CIENCE EXPERIENCES
with
HOME EQUIPMENT

LYNDE

SCIENCE EXPERIENCES WITH HOME EQUIPMENT

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by

CARLETON JOHN LYNDE, PH.D.
TEACHERS COLLEGE, COLUMBIA UNIVERSITY
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Foreword

These two hundred science experiences require only home equipment.

They have been tested many times and all are sure fire.

You will succeed in every case, if you follow the directions.

If you fail, read the directions more carefully and follow them step by step.

Do them yourself. It's more fun than looking on.

"Knowledge begins in wonder."

"All thought is based on experience."

"One experience is worth ten demonstrations."

Acknowledgment

The writer wishes to thank his colleagues, Professors Maurice A. Bigelow; Samuel Ralph Powers and Gerald S. Craig, for steady encouragement in the preparation of this series of books.

He wishes to thank also the following members of his classes for suggestions included in the series: Lincoln Baar; Clarence E. Baer; Frederick W. Bates; Mark P. Bedford; Joseph M. Cadbury; Eleanor Cleveland; Thomas F. Dolan; James K. Harris; Edgar M. Hoopes; John Dale Kelly; James F. Mason; Jesse V. Miller; Paul C. Mitchell; Ralph Preston; Charles E. Reck; Allan Scholtzhauer; C. Neale Stacy; Rudolph Steinberg; Karl Theman; Etta Ward Hastings; Robert S. Wheelock; Lester R. Willard and Edith Yelenfy.

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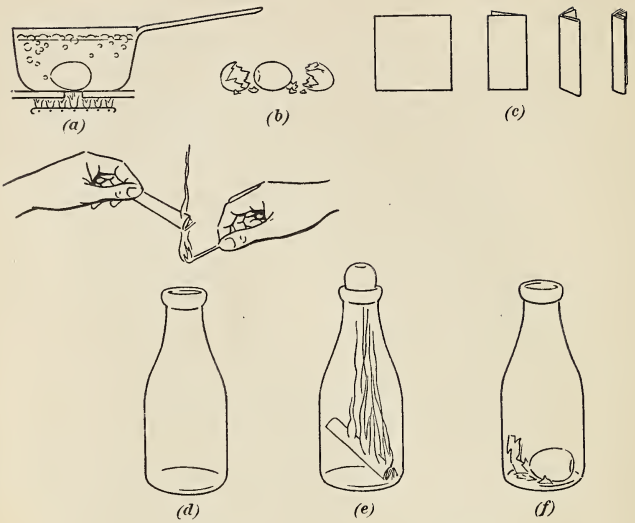


1. The Egg Pops In

a. Boil a fresh egg ten minutes.

b. Place it in cold water about ten seconds and remove the shell.

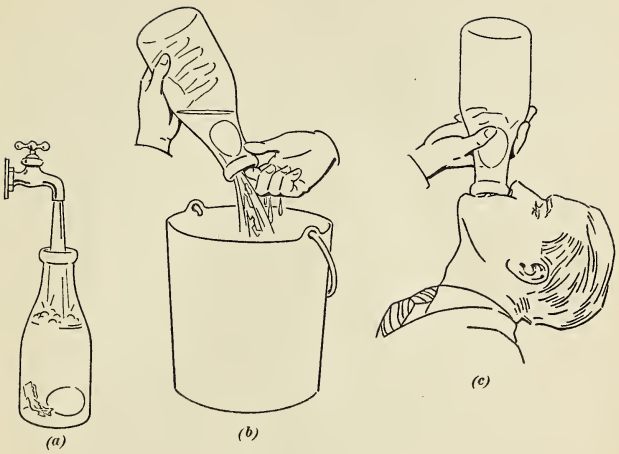
c. Fold a 4″x4″ piece of news paper, or a *single* sheet of flat toilet paper, three times in the same direction.

d. Light the paper at the lower end.

e. Drop the lighted paper into a quart milk bottle and place the shelled egg in the mouth of the bottle.

f. The egg will pop into the bottle.

Why? See page 203.



2. The Egg Pops Out

a. Fill the bottle with water.

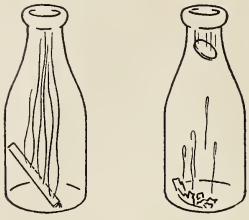
b. Invert it, hold the egg up with your finger and rinse out the burned paper.

c. Lean your head back *until your face is horizontal,* press the bottle mouth *firmly* over your own mouth and puff *hard* into the bottle.

Lift the bottle and the egg will pop out.

Be ready to catch it.

Why? See page 204.



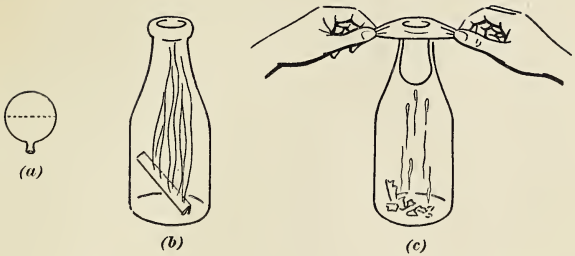
(a) (b)

3. The Milk Bottle Cap Pops In

a. Dip a cardboard milk bottle cap into hot water until it is slightly flexible. Fold a 4″x4″ piece of paper three times in the same direction, light it at the lower end, drop it into a quart milk bottle, insert the bottle cap, and cover the cap with water to make it air tight.

b. Soon you will see the cap pop into the bottle.

Fill the milk bottle with water to the top to drive out the burned air.



4. Half Balloon

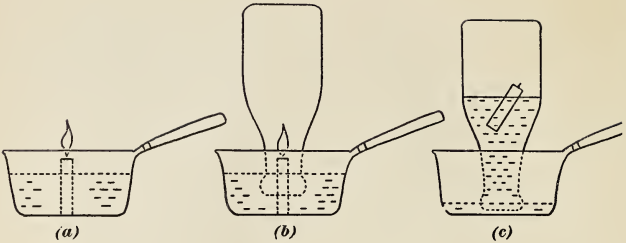
a. Cut in two a medium size round balloon, two for five cents, and save each half for future experiences.

b. Fold a 4″x4″ piece of paper three times in the same direction, light it at the lower end and drop it into a quart milk bottle.

c. When the flame has just passed its greatest height, hold the bottom half of the balloon over the mouth of the bottle.

You will see the balloon rubber stretch down into the bottle.

Fill the bottle with water to the top to drive out the burned air.



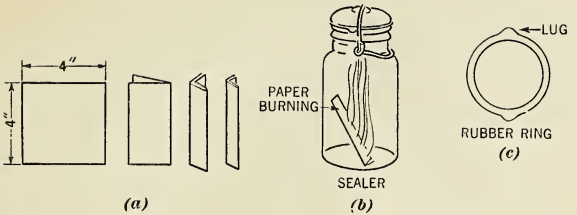
5. Milk Bottle and Candle

a. Fill a quart milk bottle half full of water and empty the water into a sauce pan. Stand a 2″ candle in the pan and light it.

b. Invert the empty quart milk bottle over the candle and hold its mouth about ¼ inch under the water surface until the hot air stops bubbling out.

c. Lower the bottle and you will see the water and candle rise up into the bottle.

Fill the bottle with water to drive out the burned air.



6. Quart Sealer

Put the rubber ring on the sealer and practice clamping down the cover until you can do it quickly.

a. Cut a piece of newspaper 4″×4″, or use a *single* sheet of flat toilet paper, and fold it three times in the same direction.

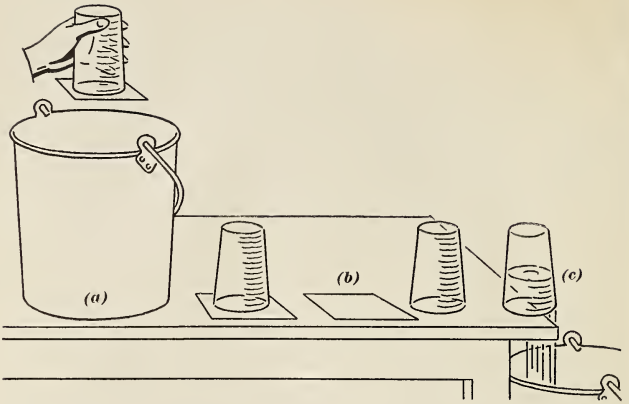
b. Light it at the lower end, drop it into the sealer, and clamp down the cover.

Wait for about one minute for the air in the sealer to cool, then unclamp the cover and try to lift it.

It is difficult.

c. Pull out the lug at the side of the rubber ring until air enters the sealer.

You can then lift the cover easily.

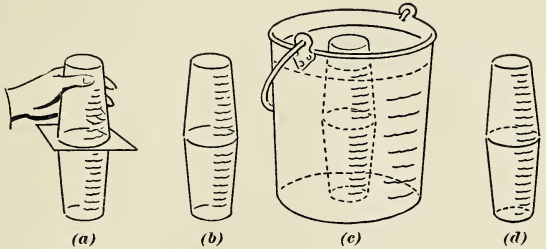


7. Tumbler and Paper

a. Fill a tumbler with water, cover it with a small piece of heavy wrapping paper, press the paper down with the palm of your hand to force out air and some water, invert both over a pail and remove your palm. The paper will stay on the tumbler.

b. Place the inverted tumbler and paper on the table and slide out the paper. The water will remain in the tumbler.

c. Slide the tumbler to the edge of the table and empty it into a pail.



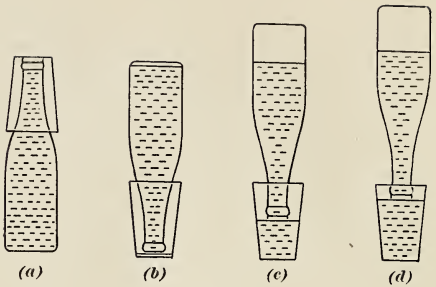
8. Two Tumblers

a. Fill two tumblers with water, press a paper down on one and invert it over the other.

b. Slide the paper out carefully and both tumblers will remain full of water.

c. Fill two tumblers under water and invert one over the other.

d. Lift the tumblers out carefully and both will remain full of water.



9. Soda Bottle and Tumbler

a. Fill a soda bottle with water and invert an empty tumbler over its mouth.

b. Hold the tumbler and bottle together and invert both. A little water will run into the tumbler.

c. Lift the bottle two inches and hold it steady in this position. Air flows into, and water out of the bottle, but both stop as soon as the water level in the tumbler reaches the mouth of the bottle.

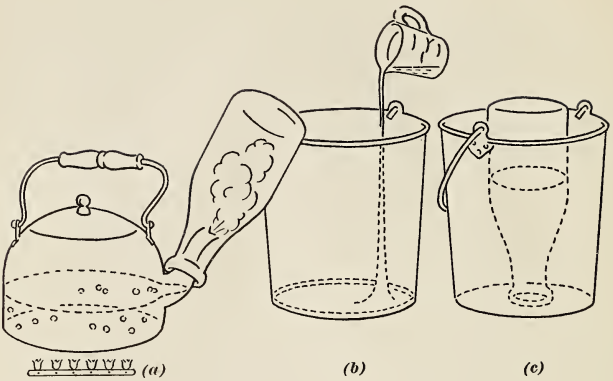
d. Lift the bottle another inch and hold it. Again air flows into, and water out of the bottle, and again both stop when the water level in the tumbler reaches the mouth of the bottle.

10. Gallon Can

a. Pour a tumbler of water into a gallon can with a screw cap, place the *open* can on the stove and boil the water until the steam has issued for 1 minute or more.

b. Turn off the gas, screw on the cap, invert the can and place it cap down in a pan or pail of water. The can will collapse.

c. Put the *closed* can on the stove again, light the gas and let the steam blow the can back nearly to its first shape. Turn off the gas before it goes too far.



11. Tea Kettle Steamer

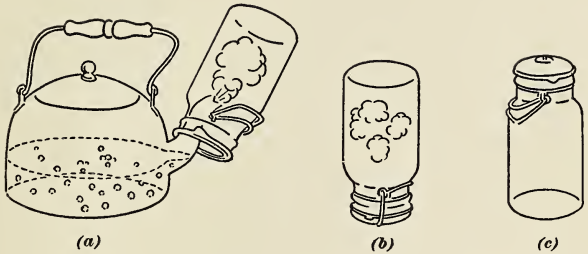
Pour water into a tea kettle until it covers only the lower half of the hole leading into the spout. The steam can then enter the spout.

To get water into an upside-down milk bottle.

a. Place the milk bottle over the spout of a tea kettle and steam it inside for 1 minute.

b. Pour four cups of warm water into a large pail.

c. Invert the milk bottle quickly into the pail and the water will run up into it.

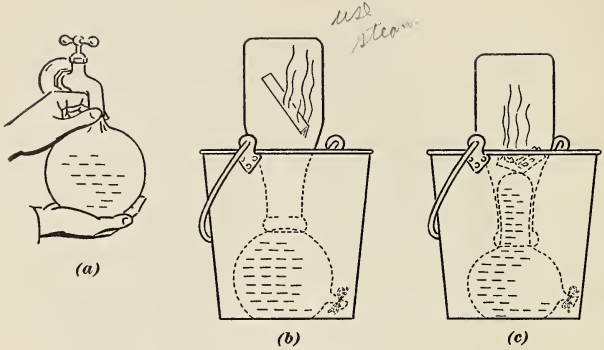


12. Sealer

a. Steam the inside of a sealer for about one minute.

b. Hold it upside down and clamp on the cover quickly.

c. Let the steam condense for two or three minutes, unclamp the cover and try to lift it.
It is difficult.

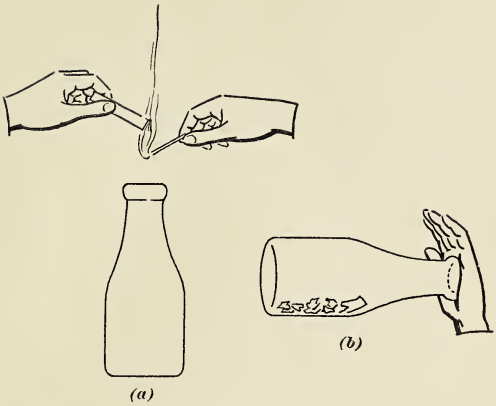


13. Milk Bottle and Water Balloon

a. Fill a large round balloon with about a quart of water and tie it.

b. Place the balloon in an empty pail. Light a folded 4″×4″ piece of paper, drop it into a quart milk bottle and quickly press the mouth of the bottle against the balloon.

c. Part of the water balloon will move up into the bottle.

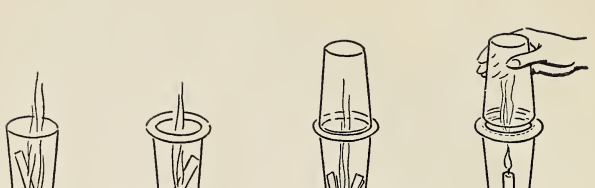


14. Milk Bottle and Palm

a. Fold a 4″×4″ piece of paper three times in the same direction and light it at its lower end.

b. Drop it into a quart milk bottle, turn the bottle on its side and press your palm against the mouth of the bottle. You will feel your palm sucked into the bottle.

c. *Fill* the bottle with water and empty it to drive out burned air and let in fresh air.



15. Two Tumblers

a. Find two similar thick tumblers with smooth rims and fit one with a wet blotting paper collar. Drop lighted paper into each tumbler.

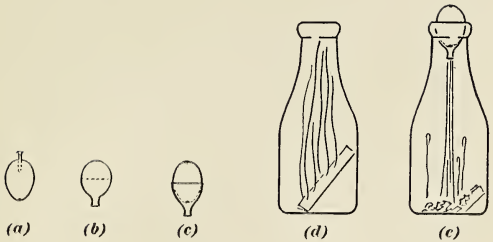
b. Invert one over the other and press them together for about one-half minute.

Lift the upper tumbler and you will lift the lower one also.

c. Fill and empty the tumblers with water to renew the air, light a short candle in the lower tumbler, put on the wet collar, hold the upper tumbler ¼″ above the collar until the candle goes out and then press the tumbler down on the collar for one-half minute.

Lift the upper tumbler and you will lift the lower one also.

NOTE. These will go better if you can make the collar out of flat rubber.



16. To Suck an Egg

a. Punch a small nail hole through the shell and inner skin at each end of a fresh egg.

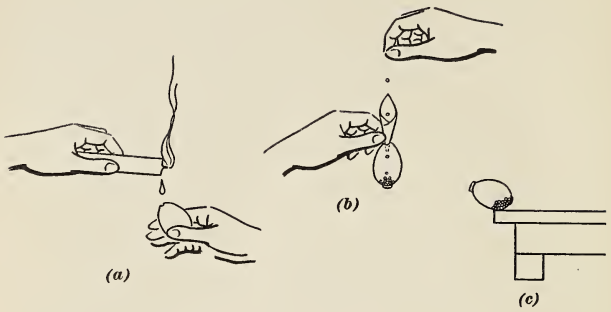
b. Find a balloon a little larger than the egg and cut it in halves.

c. Pull the mouth half of the balloon over one end of the egg to serve as a gasket.

d. Fold a 4″×4″ piece of paper, light it at the lower end and drop it into a quart milk bottle.

e. Hold the gasket-covered end of the egg air-tight in the mouth of the bottle and the contents of the egg will flow into the bottle.

NOTE. Put the empty egg shell aside to dry for a week or so and then use it in the next experience.

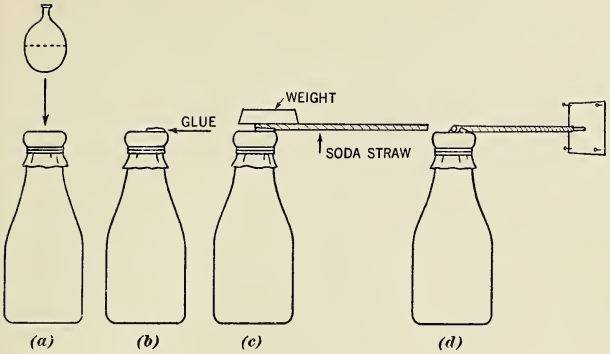


17. Empty Egg Shell

a. After the empty egg shell, of the last experience, is dry, light a candle and use the soft wax to seal one hole.

b. Make a small paper funnel and pour bird shot into the shell until it is about ⅕ full, then seal the other hole.

c. You can then balance the egg almost anywhere.



18. Barometer

a. Fasten the bottom half of a round balloon air tight over the mouth of a quart milk bottle by means of a doubled rubber band.

b. Put some glue on the balloon rubber from middle to one side.

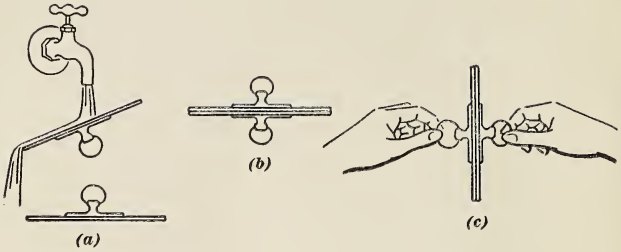
c. Put one end of a soda straw in the glue, being sure that the end of the straw is at the middle of the rubber.

Put a light weight on the straw and rubber until the glue holds.

d. Put a match stick into the other end of the straw to serve as a pointer. Place this barometer with its pointer near a piece of paper pinned to the wall.

Mark the position of the pointer each day. It rises when the atmospheric pressure rises, and vice versa.

This barometer is accurate only when its temperature is constant.



19. Two Sink Stoppers

a. Wet the bottom of two sink stoppers.

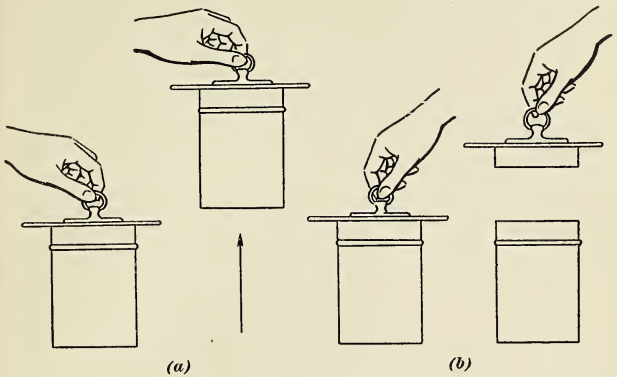
b. Press the bottoms together to drive out the air between them.

c. Try to pull the stoppers apart. You will find you cannot do it without tearing the rubber.

A sink stopper is a flat rubber disk about six inches in diameter which costs five or ten cents. Buy two, and be sure:

1. That they are flat all over the bottom.
2. That they have a rubber knob at the *center* of the upper surface.

Make a horizontal hole through this center knob and insert a metal ring or stout cord for a handle.

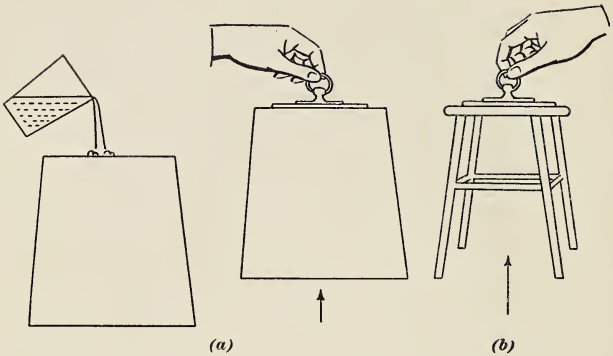


20. Sink Stopper and Coffee Can

a. Fill an uncovered 1 lb. coffee can with water, then press a sink stopper down on the water and lift it. You will lift the can and water.

b. Press the cover down tight on the can and wet it, then press down the sink stopper, hold the can and lift the stopper.

You will remove the cover easily.

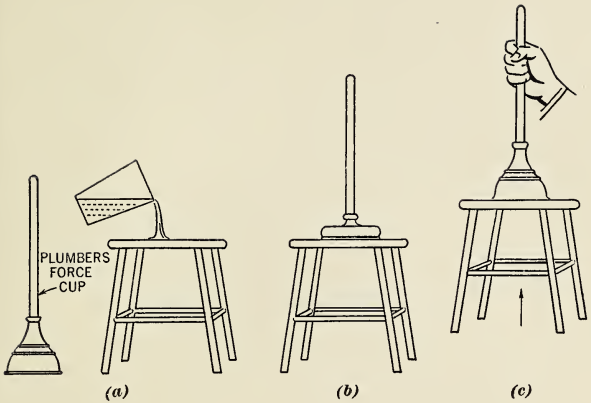


21. Sink Stopper, Pail and Stool

a. Wet the smooth bottom of a pail, press down the sink stopper and lift it.

You will lift the pail also.

b. Wet the smooth seat of a stool or chair, press down the sink stopper and lift it. You will lift the stool or chair also.



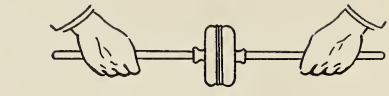
22. Plumber's Force Cup

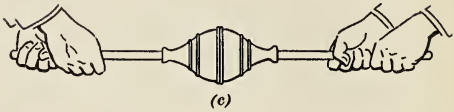
a. Spread water over the *smooth* wooden seat of a stool.

b. Press the plumber's force cup down on the seat until most of the air in the cup is expelled. Lift the cup by its handle and the stool will follow.

A plumber's force cup is a rubber half sphere with a handle. It costs 10 to 25 cents.

Buy two and be sure that the bottom rim of each is heavy and an inch wide.



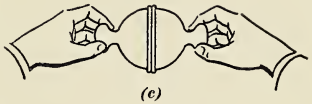


23. Two Plumber's Force Cups

a. Wet the bottom rim of two force cups.

b. Press them together to force out air.

c. Now get a friend to help you pull them apart. You will find it hard to do.



24. Suction Cups

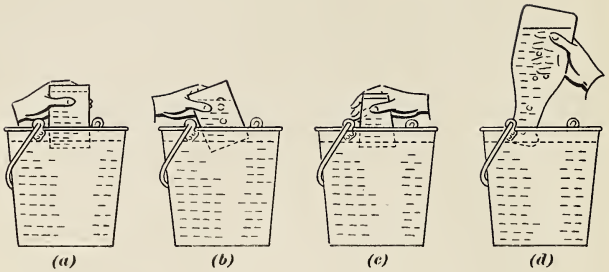
a. Wet the bottom edge of each suction cup.

b. Press the cups together to expel the inside air.

c. Try to pull them apart.
You will find it hard to do.

Suction cups three inches in diameter are sold as coat hangers. They cost ten cents each.

Buy two, remove the metal coat hanger from each and substitute a stout cord for a handle.



25. Coffee Can, Tumbler and Milk Bottle

a. Fill a coffee can with water and raise it bottom up but keep its mouth under water.

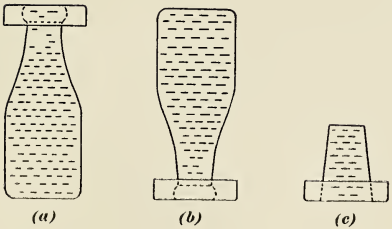
The can will feel heavy.

b. Let in air a little at a time.

The can will feel lighter and lighter.

c. Repeat *a.* and *b.* with a tumbler

d. Repeat *a.* and *b.* with a milk bottle.

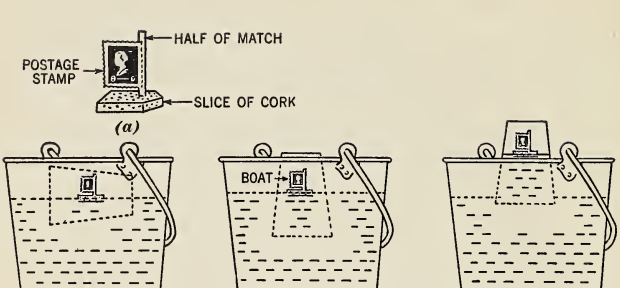


26. Milk Bottle, Tumbler, and Coffee Can Cover

a. Fill a milk bottle with water, hold a coffee can cover over its mouth and invert both.

b. The water will remain in the bottle.

c. Repeat *a* and *b* with a tumbler.



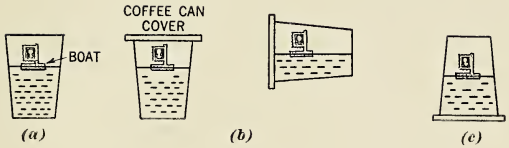
27. To Raise a Boat

a. Make a small boat from a slice of cork, with a half match for a mast and a postage stamp for a sail.

b. Float the boat, then put a tumbler sidewise over it and slowly turn the tumbler bottom up with the boat inside.

c. Raise the tumbler but keep its mouth under water.

The boat will rise, with the water in the tumbler, and float above the water level in the pail.



28. Tumbler, Boat and Can Cover

a. Float the boat in a tumbler partly filled with water.

b. Hold the cover of a coffee can over the tumbler and slowly turn them upside down.

c. The water remains in the tumbler and the boat floats on it.

(a)

(b)

29. Soda Straw

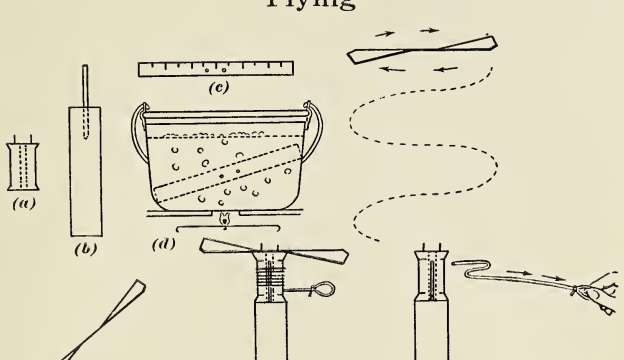
a. Bend a soda straw slightly in three or four places near the middle to make a U. Be careful not to close the hole nor break the straw.

Hold a tumbler with its mouth about one half inch under water and insert the U.

Suck out air and water will rise in the tumbler. Blow in air and the water will sink.

b. Place the U in a tumbler of water and suck air out of the outer end.

Water will flow through the U from the upper tumbler to the lower.



30. To Make a Helicopter

a. Drive two small nails into one end of a spool, on opposite sides of the hole and equal distances from it. Cut off the heads of the nails.

b. To make a support, drive a large nail into one end of a piece of wood about 4″×1″ and cut off its head.

c. Buy a 6″ celluloid ruler and bore holes at equal distances from its center, to engage the nails in the spool. Make the holes a little larger than the nails.

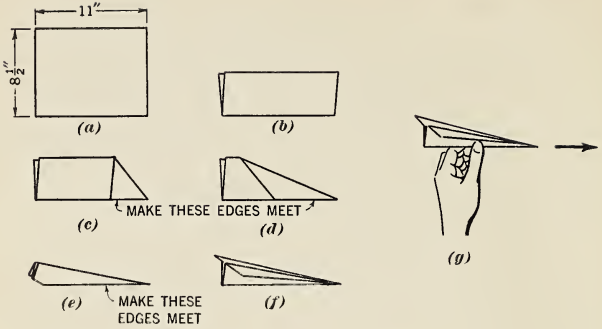
d. Put the ruler into boiling water until the celluloid is soft.

e. Take it out and bend the ends of the ruler in opposite directions to make a propeller. Hold them until the celluloid cools and hardens.

f. Wind a cord around the spool in such direction that when it is unwound it will turn the propeller in the right direction to rise. Put the propeller on the spool and the spool on the support.

g. Hold the support in one hand and pull the end of the cord hard with the other to twirl the spool.
The propeller will spin and rise to a considerable height.

NOTE: To make propellers out of cardboard: Cut strips 6″×1″. Wet them, bend them into propeller shape and let them dry in this shape over night.



31. Dart

Make a paper dart as follows:

a. Find a piece of writing paper about 11"x8½".

b. Fold it lengthwise down the middle.

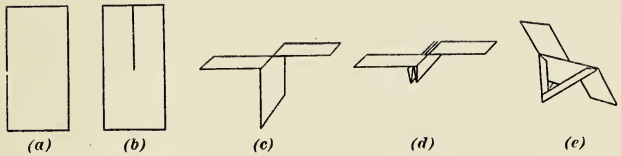
c. Fold back each corner at one end and make the edges meet.

d. Fold back the same ends again and make the edges meet.

e. Fold back the same ends again and make the edges meet.

f. Lift the wings until they are horizontal.

g. Throw the dart with the point forward. It will sail a long distance.



32. Autogyros

a. Cut pieces of paper about 6″x3″.

b. Cut them in half lengthwise for 3″.

c. Fold the wings in opposite directions.

d. In some, fold up the tail over and over.

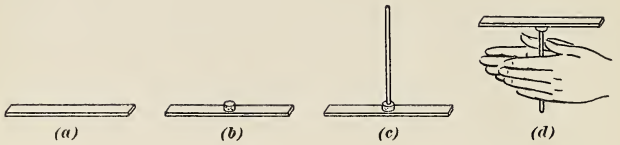
e. In others, fold in the corners of the tail twice.

Stand on a chair, hold them above your head and let them fall.

They will spin to the floor without turning over.

Go upstairs and throw them out of a window.

They will spin to the ground without turning over, and sometimes they will soar to great heights in upward air currents.



33. An Autogyro

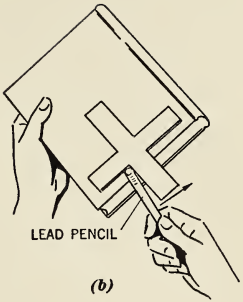
a. Cut a strip of cardboard about 7″x¾″.

b. Cut a half inch slice of a small cork and glue it to the exact middle of the strip.

c. Sharpen the *round* stick of an all-day-sucker and glue it into the exact center of the cork.

d. Twirl the stick between your hands and release it. The autogyro will spin slowly to the floor without tipping.

(a)

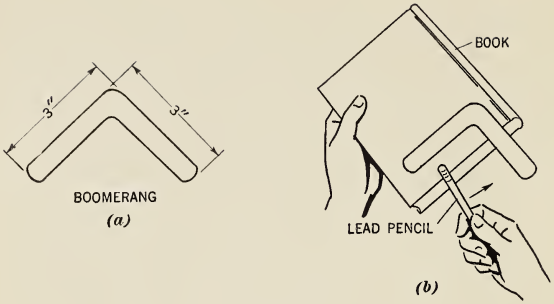


(b)

34. Autogyro

a. Cut out of smooth cardboard a cross with arms about 3″x1″.

b. Place it on a book, point the front edge of the book upward and strike a projecting arm of the cross with a lead pencil in such a way as to make it spin. The autogyro (cross) will glide away with a spinning motion and return to your feet without turning over.

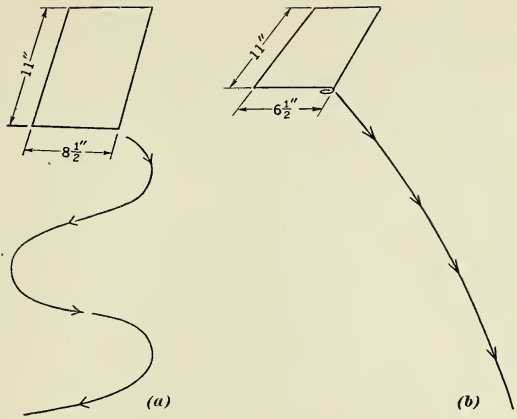


35. Boomerang

a. Cut a boomerang out of smooth, stiff cardboard with the arms about three inches long and 1 inch wide.

b. Place it on a book, point the front edge of the book upward and strike one arm with a lead pencil in such a way as to make the boomerang spin.

The boomerang will sail away with a spinning motion and return to your feet without turning over.



36. Glider

a. Hold a large sheet of writing paper 11″×8½″ above your head with both hands and let it go.

It falls in an irregular manner and may turn over.

b. Now fold one long edge back exactly one inch; then fold it over another inch.

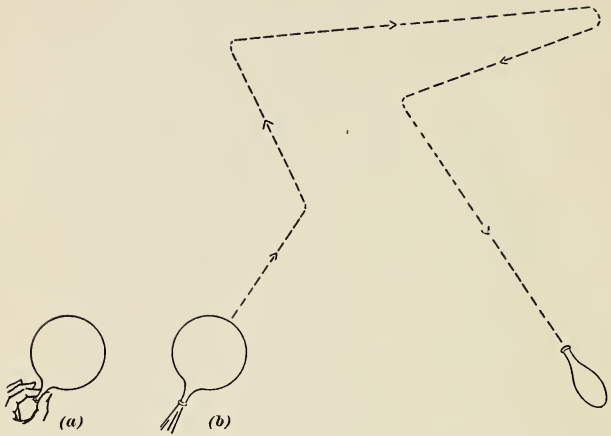
Hold the paper above your head with both hands with the folded edge under at the front.

Give it a gentle push—do not throw it. It will glide like an air plane wing without turning over.

Fold the edge over a third inch and repeat. The sheet will glide without turning over.

Fold the edge over a fourth inch and repeat. The sheet will glide without turning over.

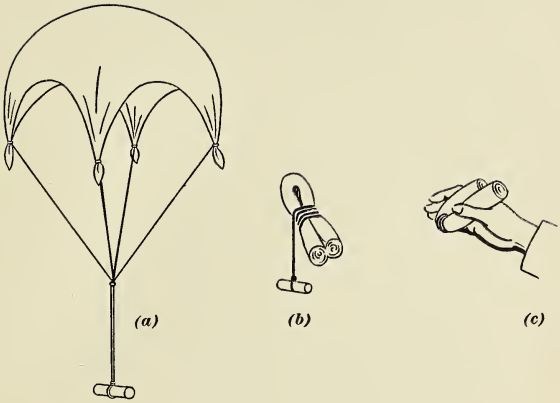
Fold the edge over a fifth inch and repeat. The sheet will drop without turning over but it will glide very little, if at all.



37. Rocket Plane

a. Blow up a round balloon and pinch its neck to keep in the air.

b. Point the round end upward and release the neck. The balloon will dart about in a lively manner until deflated. This illustrates the principle of the rocket air plane.



38. Parachute

a. Tie a string to each corner of a large handkerchief and tie the four equal strings to a weight.

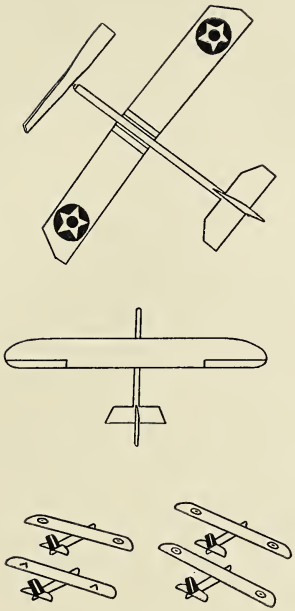
b. Fold the handkerchief and wind the strings around it.

c. Fold the handkerchief again, around the weight and throw the bundle high into the air out of doors. It will open out and float down slowly.

39. Helicopter

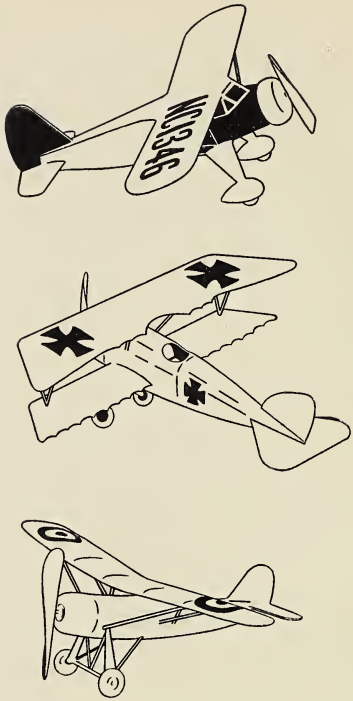
This helicopter is called Shoot-a-plane. It spins and rises straight up into the air. It costs thirty-five cents.

Sometimes you can find other helicopters for sale for ten cents.



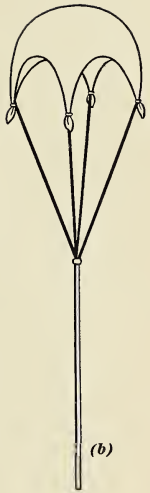
40. Gliders

For five and ten cents you can buy excellent gliders which will glide long distances.



41. Airplanes

For ten to twenty-five cents you can buy excellent air planes which will fly long distances.



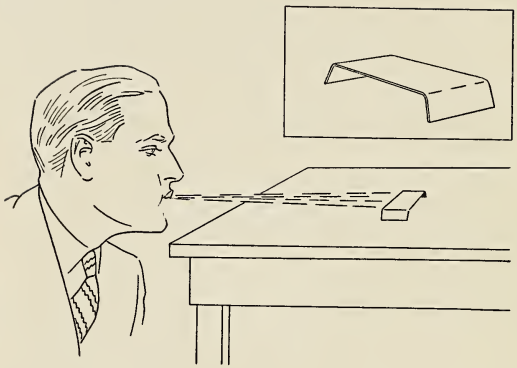
42. Parachute

a. Place one end of the guide stick at the center of the cloth. Put the other end through the hole in the catapult and on the rubber band. Pull the guide stick and band downward ten or twelve inches and shoot the stick *straight upward.*

b. The parachute will rise to a considerable height and float down slowly.

NOTE: Remember you must shoot *straight upward.* This parachute costs 10 cents.

Air Streams



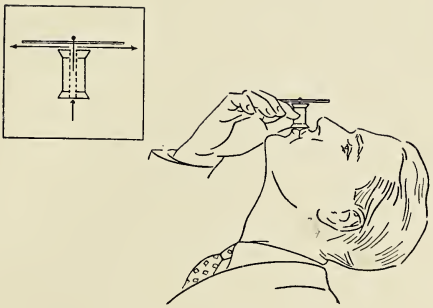
43. You Cannot Blow It Over

Cut a piece of cardboard about 8"x4" and bend down each end 1 inch.

Place the card on the table and try to blow it over.

The harder you blow the tighter it clings to the table.

Why? See page 208.

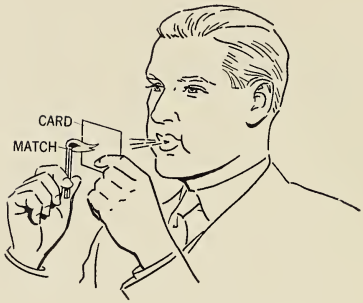


44. You Cannot Blow It Off

Cut a piece of cardboard about 3″×3″, put a pin through its middle point and put the pin in the hole of a large spool.

Bend your head back and blow hard into the hole of the spool, to blow the card off.

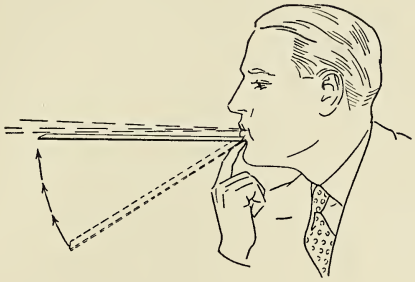
The harder you blow the tighter it clings to the spool.



45. You Blow the Flame *Toward* You

Hold a lighted match behind a card two inches wide and blow hard against the card.

The flame will move *toward* you instead of away from you.

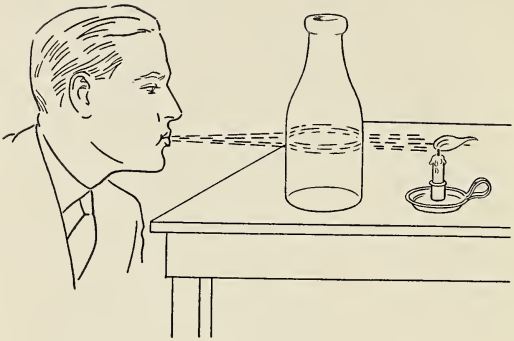


46. The Paper Rises Into the Air Stream

Cut a strip of paper about 11″x1″.

Place one end *over* a finger and hold the finger against your chin just below your mouth in such a way that the strip hangs down.

Blow *hard* over the paper and it will rise up into the air stream and flap there.



47. You Appear to Blow Through a Bottle

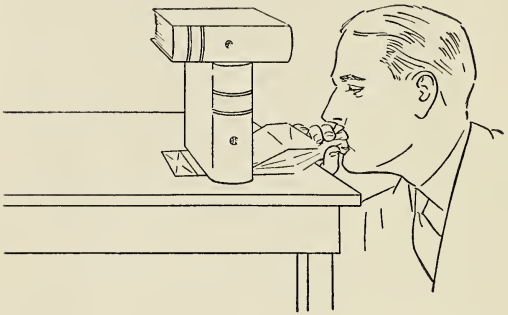
Arrange the milk bottle and lighted candle or match as above.

Blow hard against the bottle and you will blow out the flame.

48. You Lift the Cork

Place a very small cork in a quart milk bottle filled with water to *within two inches* of the top.

Blow hard into the bottle and the cork will fly out.

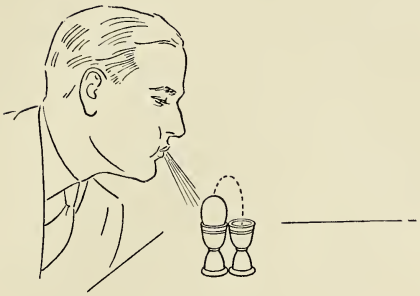


49.—To Lift a Weight With Compressed Air

Place two heavy books on an empty paper bag as illustrated.

Blow hard into the bag to inflate it and you will topple the books.

Why? See page 209.

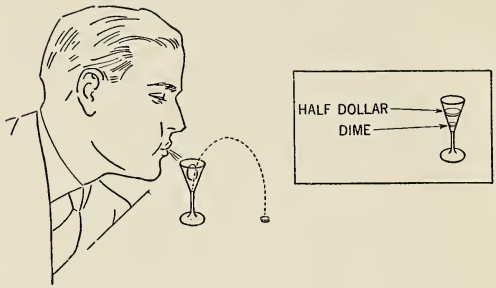


50. Egg Trick

Arrange two egg cups as above.

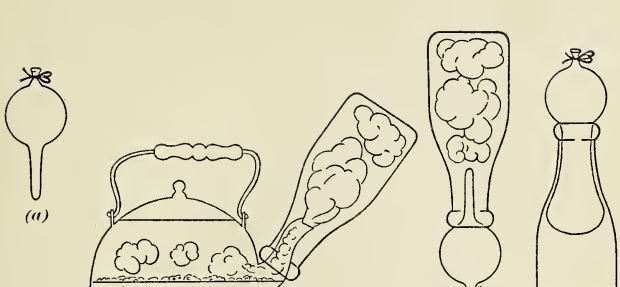
Place an egg in the near cup and blow down hard at its near side.

You will blow the egg over into the other cup. You had better use a hard boiled egg which will not spill if broken.



51. You Lift the Lower Coin

Place a half dollar and a dime in a small V-shaped wine glass. Blow hard at one edge of the half dollar and the *dime* will fly out.



52. Milk Bottle and Long Balloon

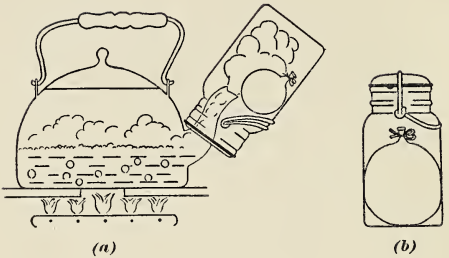
a. Blow up a long balloon until it is only half expanded and tie it so.

b. Steam the inside of a quart milk bottle for one minute.

NOTE: Be sure that the water in the tea kettle covers not more than the lower half of the hole leading into the spout. The steam can then pass through the upper half into the spout.

c. Quickly put the unexpanded part of the balloon into the bottle and hold the expanded part against the mouth to keep out air.

d. The air in the balloon will expand the balloon into the bottle as the steam condenses.

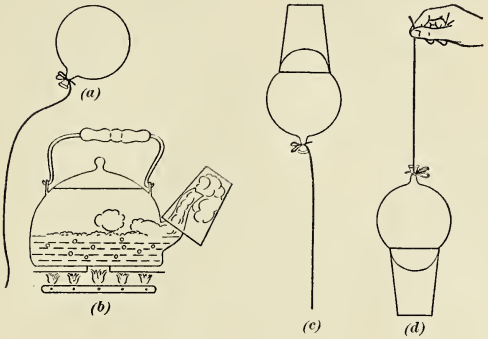


(a) *(b)*

53. The Balloon Grows

a. Blow up a balloon slightly, tie it and place it inside a sealer. Steam the inside of the sealer for 1 minute.

b. Clamp the cover on quickly and stand the sealer aside a half hour to cool. The air in the balloon will expand it as the steam condenses.



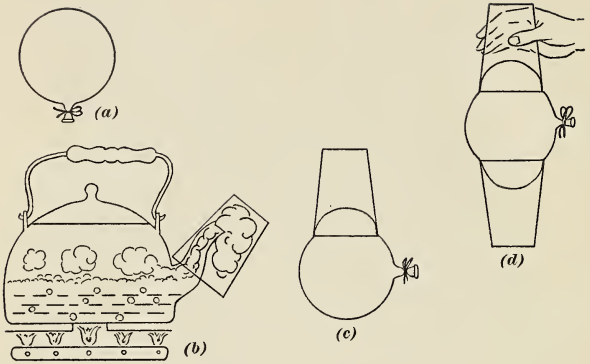
54. Tumbler and Balloon

a. Blow up a large round balloon and tie it with a long cord.

b. Steam the inside of a tumbler for one minute.

c. Put the tumbler quickly over the bottom of the balloon and hold it there. The air in the balloon will expand it into the tumbler.

d. You can then support the tumbler by means of the balloon and cord.



55. Two Tumblers and a Balloon

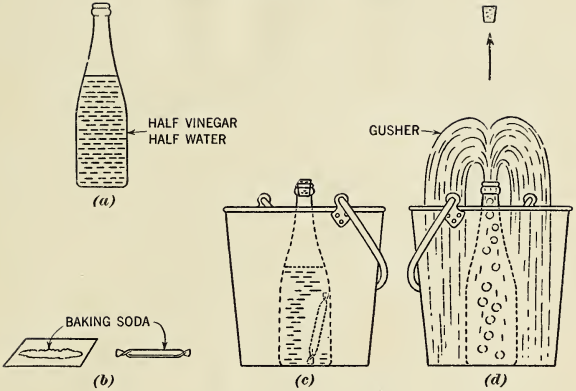
a. Blow up a large round balloon and tie it.

b. Steam the inside of a tumbler for one minute.

c. Put the tumbler quickly against the *side* of the balloon and hold it there until the steam condenses and the air in the balloon expands it into the tumbler.

d. Steam the inside of another tumbler for one minute and hold it against the opposite side of the balloon until the air in the balloon expands it into the tumbler. The balloon will hold the tumblers together.

Compressed Gas



56. A Bottle Gusher

a. Find a cork to fit a pint soda bottle.
Fill the bottle to the bottom of the neck with a mixture half vinegar and half water.

b. Put a level tablespoonful of baking soda on a single sheet of toilet paper. Make a thin roll and twist the ends.

c. Drop the roll into the bottle and shove the cork into the bottle firmly, but not too firmly.
Stand the bottle in an empty pail and shake it once vigorously to break up the roll.

d. The gas produced by the vinegar and baking soda will drive out the cork with a loud pop, and at the same time lift part of the liquid out as a fine white gusher.

57. Cannon Recoil

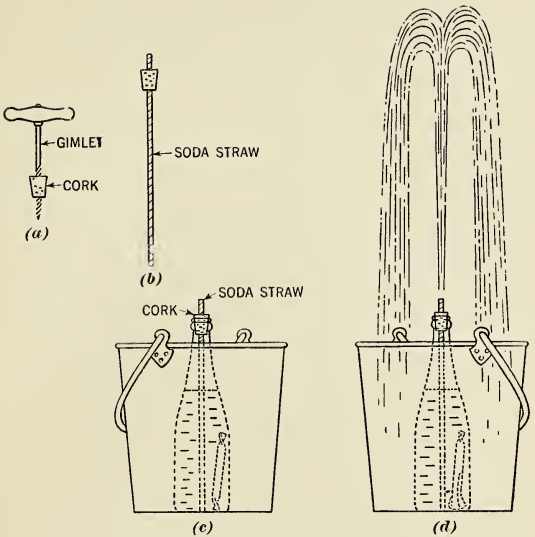
a. Prepare a bottle as in the last experience.

Go outside and prepare to lay the bottle on its side on two *round* pencils on a *smooth surface.*

Insert the baking soda roll, insert the cork, shake the bottle once and place it on the pencils.

b. Soon you will hear a loud pop and see the cork fly one direction and the bottle recoil in the opposite direction.

c. Repeat, but use *hot water* instead of the vinegar and water, and baking *powder* instead of the baking soda.



58. A Fountain

a. Use a gimlet or red-hot nail to bore a hole through a cork which fits a pint soda bottle.

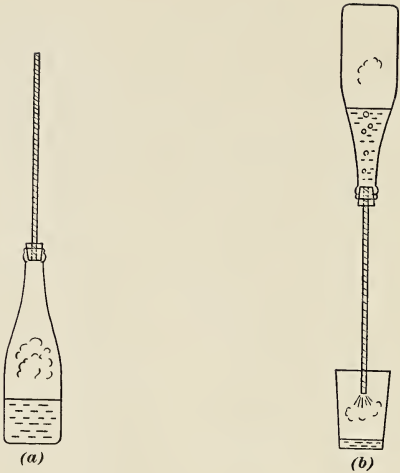
b. Fit a soda straw airtight into the hole.

c. Fill the bottle to the bottom of the neck with a mixture half vinegar and half water. Make a roll of one tablespoon of baking soda.

Place the bottle in a pail, insert the roll and stopper and shake once to break up the roll.

d. You will see a fine fountain.

e. Repeat, with hot water and baking powder, as in 57c.



59. Hiccup Bottle

a. Find a cork to fit a pint soda bottle and use a gimlet or red hot nail to bore a hole through it, large enough to fit a soda straw. Fill the bottle to a depth of 2″ *only* with *hot* water.

b. Invert the bottle and it will hiccup at regular intervals.

Cut the soda straw in half and the bottle will hiccup more rapidly.

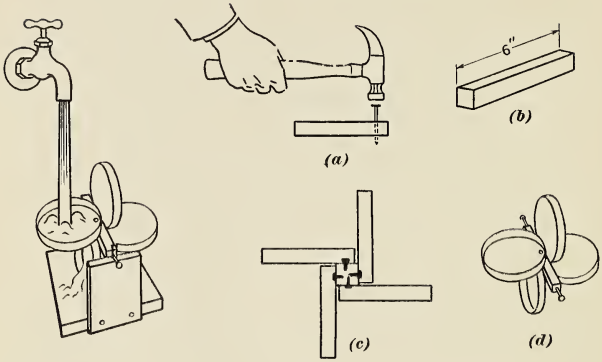
60. Balloon and Milk Bottle

Blow up a balloon until it is a little larger than the mouth of a quart milk bottle.

Wet the balloon and bottle mouth to make them slippery. Then try to force the balloon into the bottle without letting air out of the bottle.

You will find it difficult.

Water Wheels and Turbine



61. Water Wheel

Make a water wheel from four coffee can covers, as shown.

How to make it.

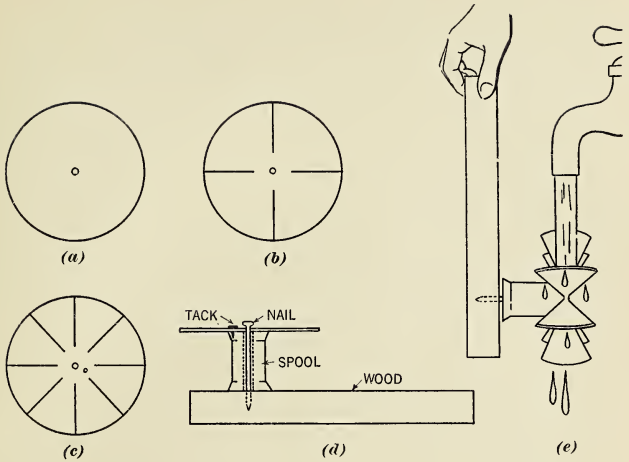
a. Punch a small hole near the edge of each coffee can cover.

b. Cut a *square* piece of soft wood about 6″ long.

c. Tack the covers to the wood.

d. Drive a nail into each end of the wood, for an axle.

e. Mount the wheel on a frame as in the first figure, with each axle between a pair of short nails. It is a powerful water wheel.



62. Water Wheel

Make a water wheel from the cut-out top of a round food can, as follows:

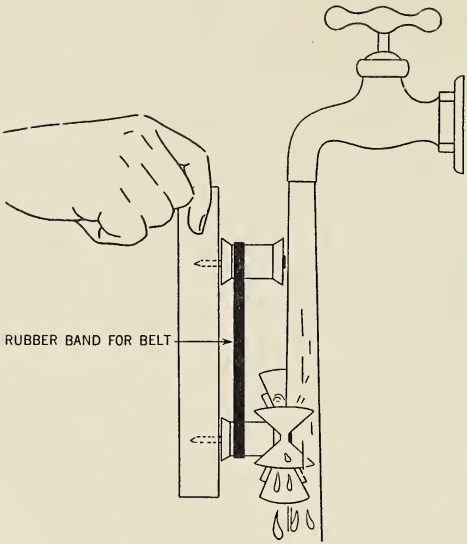
a. Punch a nail hole at the exact center.

b. With shears or heavy scissors make a cut from the edge to within ½ inch of the hole. Make a similar cut exactly opposite the first, then make two more exactly half way between the first two.

c. Make four similar cuts between the first four and make a tack hole near the center hole.

d. Tack the tin to the end of a spool and nail the spool loosely to a wooden support.

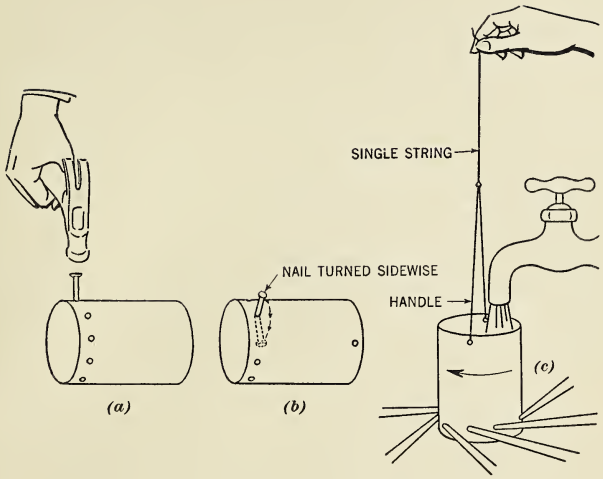
e. Bend each tin slice at right angles to make a paddle and hold this water wheel under an open faucet. It will spin merrily.



63. Water Power

Nail another spool loosely to the support at a distance which will stretch a rubber band a little but not too much.

The water wheel will drive the spool.



64. Reaction Turbine

a. Punch nail holes ½ inch apart all around the side at the bottom of a round can.

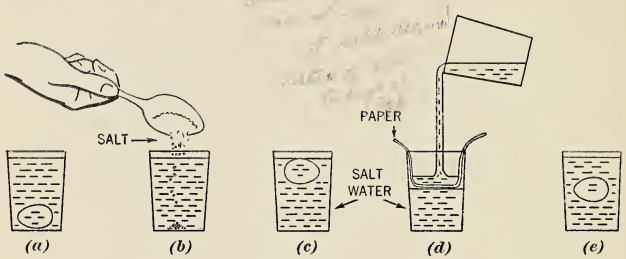
b. Put the nail in each hole again and twist each hole sidewise parallel to the bottom. Twist them all in the same direction so that all will throw the water jets sidewise in the same direction.

c. Punch two opposite holes near the top and tie in a short string for a handle.

Tie a single long string to this handle and support the can under an open water faucet.

The can will turn rapidly until the long string is wound very tight.

Buoyancy of Liquids



65. Egg in Water

a. Put a fresh egg into a tumbler of fresh water and it will sink to the bottom.

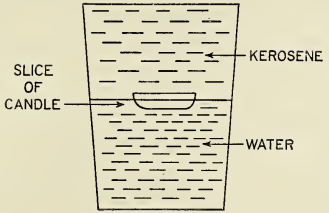
b. Dissolve three or four heaping tablespoonfuls of salt in the water.

c. Place the egg in the salt water and it will float.

d. Pour out half the salt water. Bend a strip of paper down on the salt water surface to prevent mixing and fill the tumbler with fresh water. Remove the paper slowly to prevent mixing.

e. Place the egg in the tumbler and it will float half way down.

Why? See page 211.

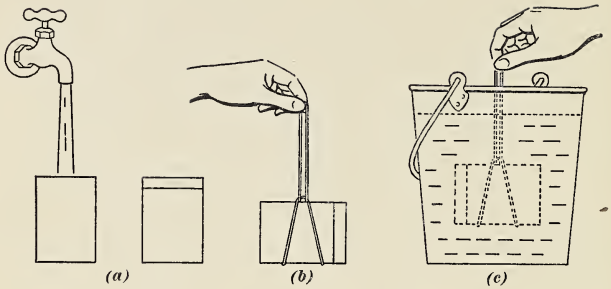


66. Buoyancy of Liquids

Fill a tumbler half with water and half with kerosene.

Drop into it a slice of a candle cut into the shape of a small boat.

The boat will sink through the kerosene but float on the water.



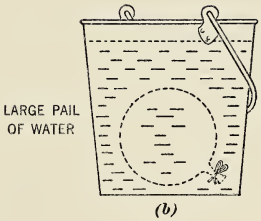
67. To Feel the Buoyancy of Water

a. Fill a coffee can with water and cover it.

b. Cut a cord three feet long, double it, tie the ends and hold up the can by the loop. It feels heavy.

c. Lower it into a pail of water and it feels light.

d. Lift it out of water and it feels heavy again.



68. To Feel the Buoyancy of Water

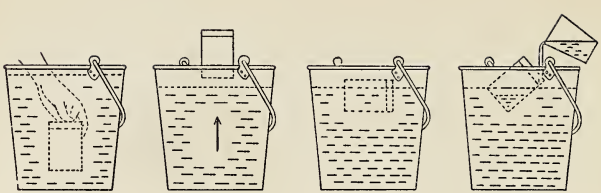
a. Blow up a large balloon *very full* and tie it with a bow knot in the cord so that you can easily untie it.

b. Sink the balloon in a pail of water and you will be surprised to see how hard you must shove down against the lift of the water.

Water wings

Two strong balloons blown up and tied together make excellent water wings.

Real water wings are, in effect, two stout connected balloons in a cloth belt.



69. Buoyancy of Water

a. Sink an empty covered coffee can in water and release it quickly. Repeat with the can in various positions.

b. The can will try, apparently, to jump out of the pail in each case.

c. Repeat with the can partly filled with water. The can will rise more slowly and it will also tip up on end.

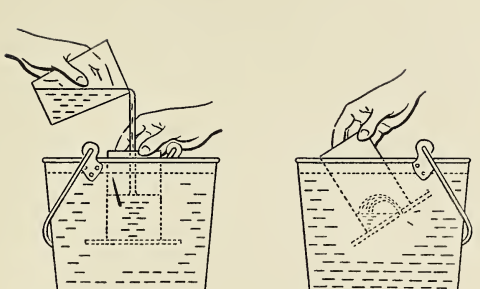
Submarines. A number of separate water tanks near the bottom of a submarine are filled with water or emptied in preparation for diving or rising.

They must be filled or emptied evenly to keep the submarine on an even keel.

d. Float an empty uncovered coffee can on water and pour in water slowly.

The can will float lower and lower but also it will become more and more upright.

Steamships. The heavy boilers and engines of a steamship are placed near the bottom to help keep the ship upright.



70. Buoyancy of Water

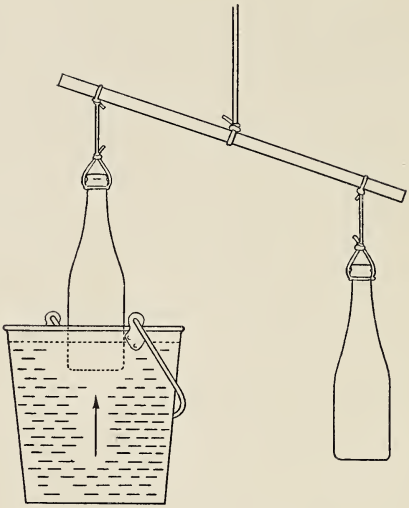
a. Cut both ends out of a food can and cut a piece of cardboard a little larger than the end. Hold the cardboard over one end and sink both under water.

The cardboard will cling to the end and keep the inside dry, when you remove your hand.

Pour water slowly into the can and the cardboard will hold until the water level inside is the same as that outside.

b. Punch a hole in the cardboard near one edge and repeat the experience with the can tilted.

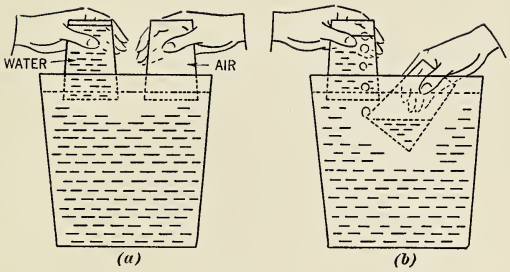
You will see a small fountain.



71. Buoyancy of Water

Balance a stick on a cord attached to the back of a chair or other support and balance two similar bottles near its ends.

Lift a pail of water up under either bottle and the water will lift the bottle.



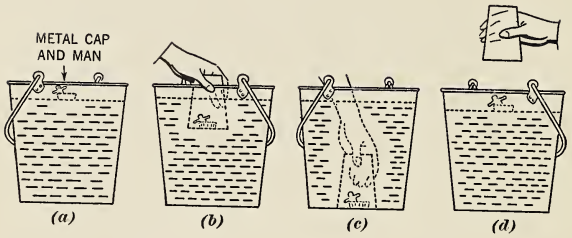
72. You Pour Air Up Hill

a. Arrange two tumblers upside down above a pail of water, one full of water and the other full of air and each with its mouth under water.

b. Tilt the air tumbler down under the water tumbler and the air will pour up hill into the water tumbler.

c. Pour the air back into the original tumbler.

Water Pressure and Air Pressure



73. Diving Bell

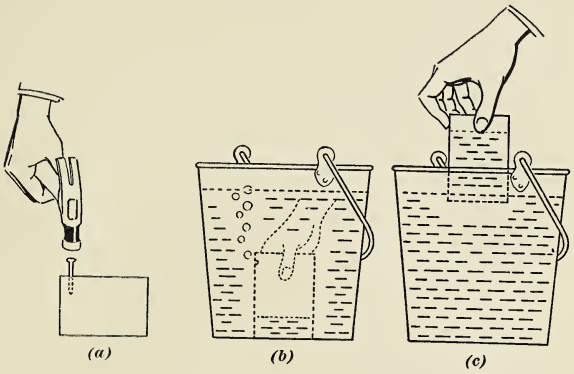
a. Remove the metal cap from a vinegar bottle or soda bottle and float it as a boat in a pail of water. Put in a little man cut out of paper.

b. Place a dry tumbler upside down over the boat and sink the tumbler half way down. The boat will float half way down.

c. Sink the tumbler to the bottom and the boat will rest on the bottom of the pail.

d. Raise the tumbler carefully and the boat will float on the surface again.

A real diving bell resembles a large steel tumbler upside down. It is supplied with air through rubber hose. In it men can work under water on the bottom of a river, lake or ocean.



74. Air Bubbles

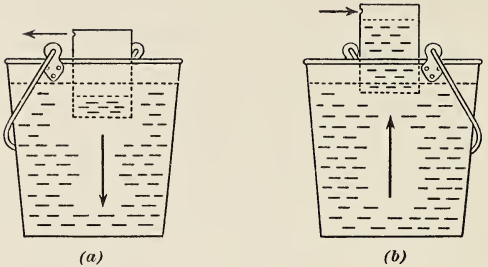
a. Punch a nail hole in the side of a coffee can about one-quarter inch from the bottom.

b. Sink the uncovered can upside down in water and air will bubble out through the nail hole.

c. Put a finger over the hole and raise the can bottom up but keep the open end under water.

Water remains in the can.

Remove your finger and the water runs out.

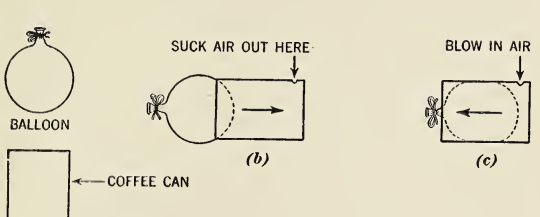


75. The Can Breathes

a. Hold your finger lightly over the hole in the side of the coffee can and sink the can upside down in water.

You feel the can breathing out.

b. Raise the can but keep its mouth under water. You feel the can breathing in.



76. Balloon and Coffee Can

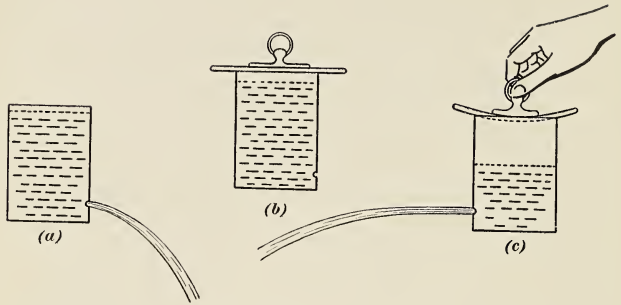
a. Blow up a round balloon until it is just a little larger than the mouth of the coffee can.

Rub the outside of the balloon with a piece of wet soap to make it slippery.

b. Press the balloon against the mouth of the can and suck air out of the can through the hole.

The balloon slides into the can.

c. Blow air into the can and the balloon slides out again.

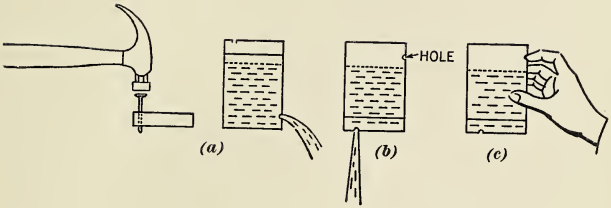


77. A Squirter

a. Fill the coffee can with water and a jet of water flows from the hole.

b. Cover the can with the sink stopper and move the middle of the stopper up and down slightly.

c. You will see a fine squirt each time you move the stopper down.



78. Stop and Go

a. Punch a nail hole in the cover of the coffee can and put the cover on the can full of water.

a. Turn the can upside down and water will run out of the hole in the cover.

c. Put your finger over the hole in the side of the can and the flow will stop.

Remove your finger and the flow will start again.

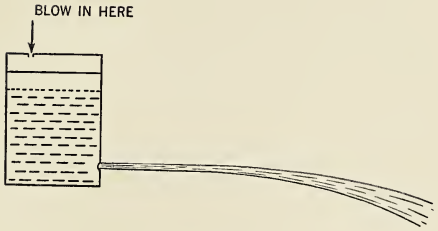
79. A Trick

Fill the coffee can with water, put on the cover, turn the can upside down and hold a finger or thumb over the hole in the side to stop the flow.

Now choose a friend who does not know about the holes, ask him to hold the can a minute, and give it to him in such a way that the hole in the cover is over his hand.

Remove your finger from the hole and walk away.

Your friend will be surprised to find his hand getting wet.



80. Air Pressure

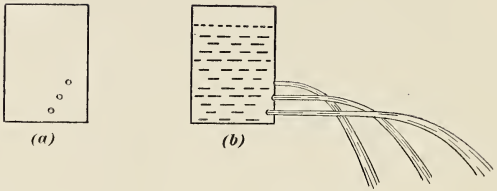
Fill the can with water, put on the cover, put your mouth over the hole in the cover and blow hard.

You will see a fine jet of water.

Suck air out through the hole in the cover.

You will stop the jet and draw air into the can.

Turn the can upside down and blow and suck air through the hole in the side.

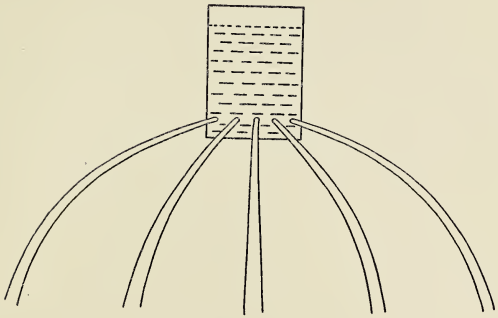


81. Three Holes in the Can

a. Punch two more nail holes in the side of the coffee can, the first, one inch above the hole already there and a little to one side, the second 1 inch above the second hole and a little more to the same side.

b. Fill the can with water, hold it high above a sink and you will see three fine jets.

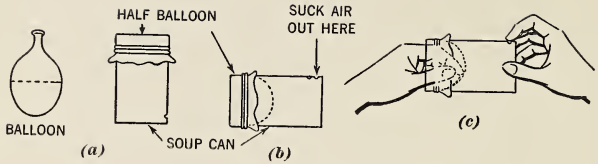
The longest jet is at the bottom and the shortest at the top.



82. Many Equal Jets

Take another coffee can and punch five or six holes in the side about ⅛ inch from the bottom and ½ inch apart.

Fill the can with water, hold it high above a sink and you will see streams of equal length.



83. Soup Can

a. Find a round can of about the size used for canned soups. Cut a large round five cent balloon in two and fasten the bottom half over the open end of the can by means of a doubled rubber band.

NOTE: The open end of the can must be smooth around the edge to avoid cutting the rubber.

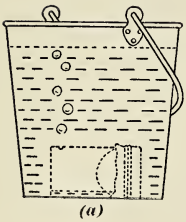
b. Punch a nail hole ⅛ inch from the bottom of the can. Suck air out of the can and the balloon rubber will move into the can.

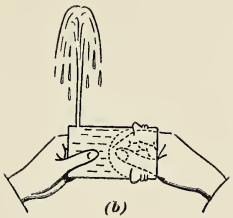
Let in air and the rubber will come out.

c. Press the rubber into the can and then put your finger over the hole in the side.

The rubber will stay in the can.

Let air into the can a little at a time and the rubber will come out a little each time.

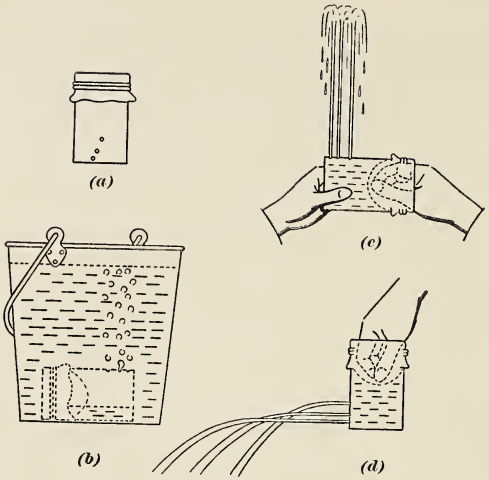




84. A Fountain

a. Hold the soup can horizontally under water and shove in the balloon rubber time after time until air bubbles stop coming out of the hole.

b. Lift the can out and shove in the rubber. You will get a fine fountain.



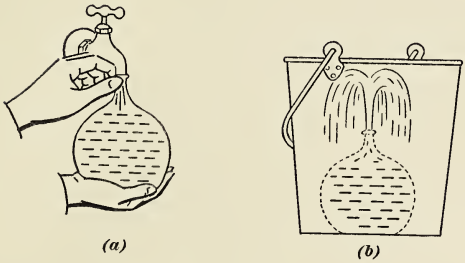
85. Triple Fountain

a. Punch two more holes in the soup can, ¾ inch and 1½ inches respectively above the first, and each ¼ inch to one side of the hole just below.

b. Hold the can horizontally in a pail of water and shove in the balloon rubber time after time until the air bubbles stop coming out of the holes.

c. Lift the can out, hold it with the holes on the top and shove in the rubber. You get three fine jets of *equal* height.

d. Hold the can high above a sink with the holes sidewise. Shove in the rubber and you get three jets of *unequal* length.



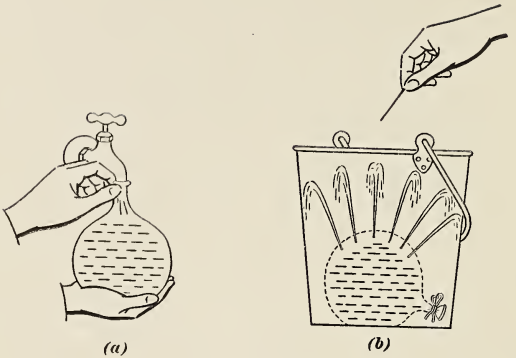
(a) (b)

86. A Gusher

a. Fill a balloon with water while you support its weight below.

b. Pinch the neck, remove the balloon from the faucet, stand it in a pail or sink and release the neck.

You will see a fine gusher.



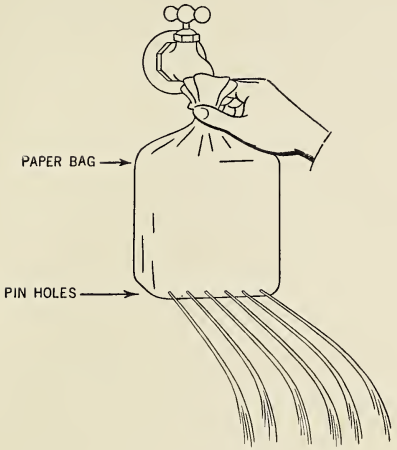
(a) (b)

87. Equal Jets

a. Fill a large five cent balloon not more than half full of water and tie it.

b. Place it in a pail or sink and punch pin holes all over its upper surface. The water jets will come out with equal force in all directions.

NOTE: You must use a balloon half full and made of fairly thick rubber. A balloon filled too full or made of thin rubber will burst at the first pin hole.



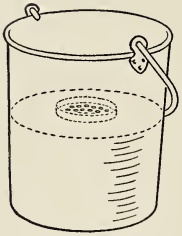
88. Equal Jets

Punch pin holes in a paper bag at the same distance from the bottom.

Gather the top of the bag around the mouth of a water faucet and fill the bag with water.

You will see fine water jets of equal length.


(a)


(b)


(c)

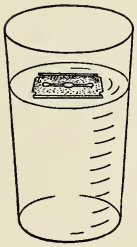
89. Can Cover

a. Punch many nail holes in the cover of a coffee can. Use a brad, that is, a very small nail.

b. Place the cover on water and it will float, although it is full of holes.

c. Hold it under an open faucet and it will hold water, although it is full of holes.

Why? See page 213.



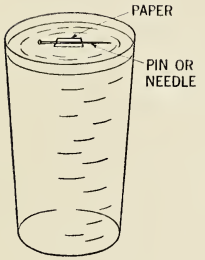
90. Razor Blade

Drop a dry safety razor blade flat on the surface of water from a height of about 1/8 inch. It will float on the surface although steel is about eight times as heavy as water volume for volume.

91. To Float Pins and Needles on Water

Hold a dry pin or needle level with the water surface and ⅛ inch above it.

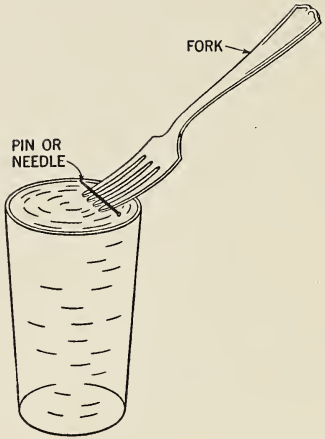
Drop the pin or needle and it will float.



92. Pin and Paper

Float a small piece of paper on water and drop a dry pin or needle on the paper.

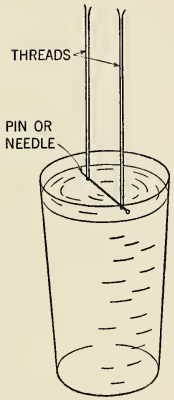
Sink the paper carefully and the pin or needle will float on the surface of the water.



93. Fork

Fill a tumbler *to the very top* with water. Balance a dry pin or needle on the dry tines of a fork and let it roll horizontally onto the water surface from a height of about $\frac{1}{8}$ inch.

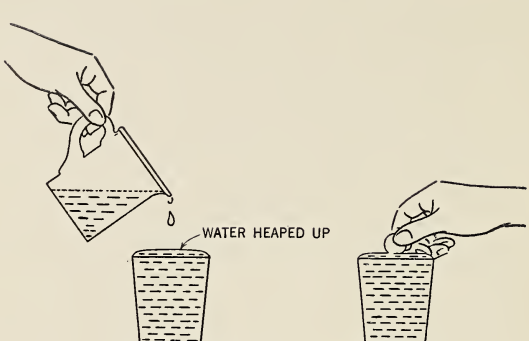
The needle or pin will float on the water surface.



94. Needle and Threads

Lower a dry needle or pin to the surface of water by means of two loops of thread.

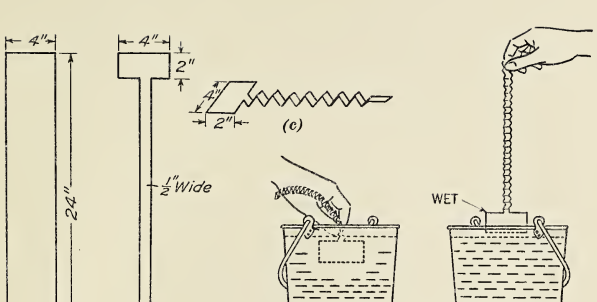
The needle or pin will float on the surface when the thread is removed.



95. Heap Up Water

a. Place a tumbler in a saucer and fill it with water. Notice that you can heap the water up an eighth inch or more above the top of the tumbler.

b. Fill a tumbler *level* full and drop in coins edgewise. You will be surprised to see how many you can drop in without making the water overflow.



96. The Water Surface Jerks the Paper Down And Tries to Hold It

a. Cut a strip of light wrapping paper 4″x24″.

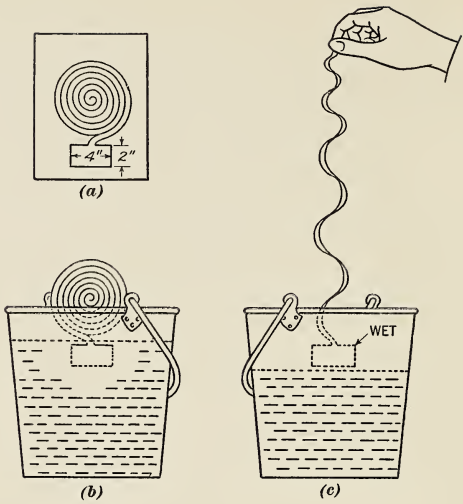
b. Cut it down to the shape shown.

c. Fold the long part back and forth into zigzags, each 1 inch long.

d. *Wet* the 4″x2″ part.

e. Hold the zigzag as shown and *very slowly* bring the wet 4″x2″ part into contact with the water surface. The water surface will grab the wet part and jerk it down.

f. Raise the zigzag *very slowly*.
The water surface will hold the wet part for a time and stretch the zigzag.



97. The Water Surface Jerks the Paper Down And Tries to Hold It

a. On a piece of light wrapping paper mark a rectangle 4″x2″ and then draw a spiral ½ inch wide above it.

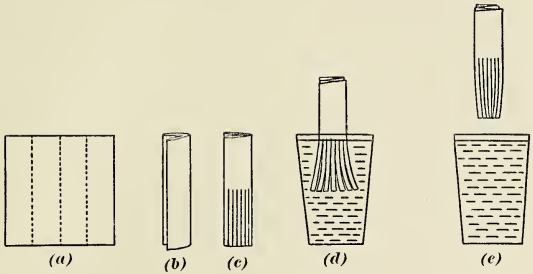
Cut out the rectangle and spiral.

b. Wet the rectangle.

c. Hold the spiral at the top and *very slowly* bring the wet rectangle into contact with the water surface. The water surface will *jerk* the rectangle downward.

Raise the spiral *very slowly*.

The water surface will hold the wet rectangle for a time and stretch the spiral.



98. In and Out of Water

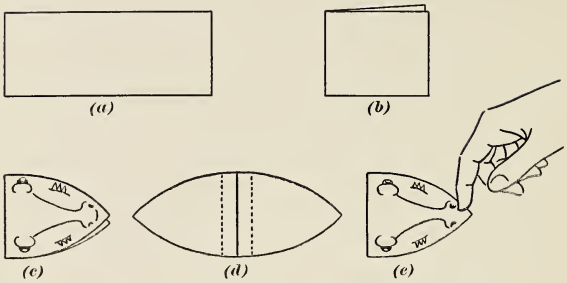
a. Cut a piece of thin paper about 4″x4″.

b. Fold it over four times.

c. Cut one half of it lengthwise into strips to make a brush.

d. Insert the brush into water and the strips will remain separated.

e. Lift the brush out of water and the strips will cling together.



99. The Alligator Opens Its Mouth

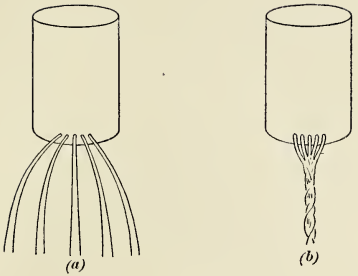
a. Cut a piece of smooth writing paper or wrapping paper about 5″x2″.

b. Fold it.

c. Cut it into the shape of an alligator head and draw its eyes and nose.

d. Wet the *crease* on the *inside only.*

e. Close the jaws by pressing down on the *end of the nose.* When you remove your finger the alligator will open its mouth.

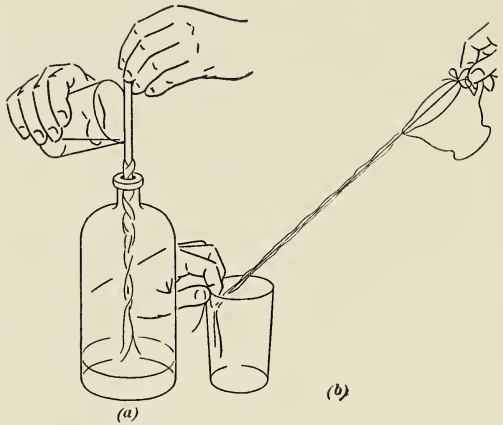


100. The Jets Cling Together

a. Punch five holes ¼ inch apart in the side of a coffee can near the bottom. Fill the can with water and you will see five equal jets.

b. Pinch the jets together with thumb and finger and they will cling together.

Slap the jets down close to the can and they will separate.



101. Aqueducts

a. Wash a pencil thoroughly with soap and water to remove the grease, then fill a tumbler half full of water and empty it into a narrow neck bottle with the aid of the pencil. The water will cling to the pencil.

b. Tie a *wet* string to the handle of a cream pitcher full of water, lay it in the notch of the spout and pour the water along it into a tumbler below and at one side. The water will cling to the string.

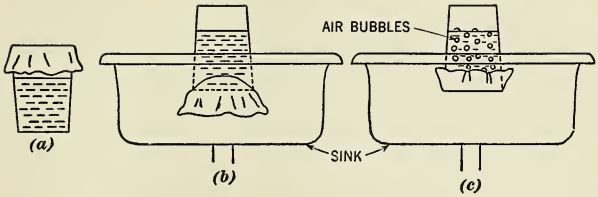
102. Matches

Place a drop of water on three matches bunched together and you can lift all three by lifting one.

103. Cloth Holds Water

a. Wet a piece of handkerchief thoroughly and fasten it by means of an elastic band over a tumbler full of water.

b. Go to a sink and invert the tumbler *quickly*. The cloth will hold the water in the tumbler.



104. The Water Appears to Boil

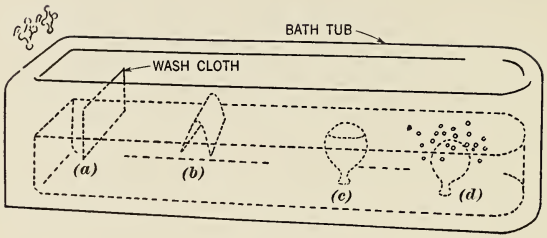
a. Wet a piece of handkerchief or other cloth and place it over a tumbler ⅔ full of water.

b. Hold the handkerchief on with the palm of your hand, invert the tumbler over a sink and remove your hand.

The handkerchief will be bent up into the tumbler and will hold the water without other support.

c. Hold the cloth all around except at one corner and pull up on this corner slowly to remove the bend.

Air will bubble up into the tumbler and make the water seem to boil.



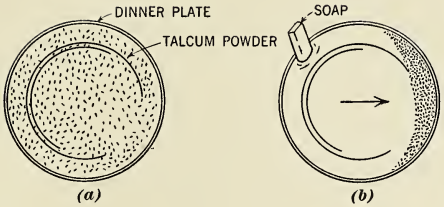
105. To Catch Air in a Wash Cloth

a. When you take your bath tonight, wet the wash cloth thoroughly and hold it with one edge under water.

b. Bend the upper edge down quickly.

c. Gather the cloth into a bag upside down.

d. Sink the bag under water and squeeze it.
Many air bubbles will appear in the water.

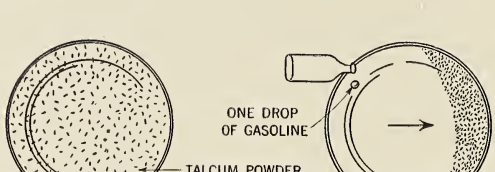


106. Water and Soap

a. Rinse a large clean dinner plate thoroughly, fill it with clean cold water, wait for the surface to become quiet and sprinkle the surface lightly with talcum powder.

b. Wet a piece of soap at the faucet and touch it to the water surface at one edge of the plate. The talcum powder will be drawn instantly to the opposite edge.

Remember, in the next half dozen experiences, always to rinse the plate very thoroughly in cold running water after each trial and to fill it with cold water without letting the water touch your fingers.

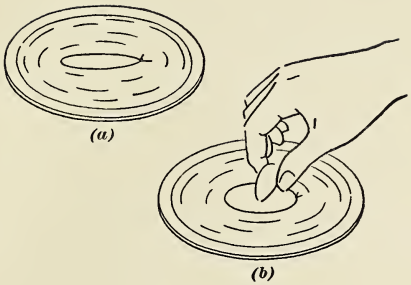


107. Water and Gasoline

a. *Rinse the dinner plate thoroughly,* fill it again with clean cold water, wait for the surface to become quiet and sprinkle it lightly with talcum powder.

b. Let one drop of gasoline fall on the water surface near one edge. The talcum powder will be drawn instantly to the oposite edge.

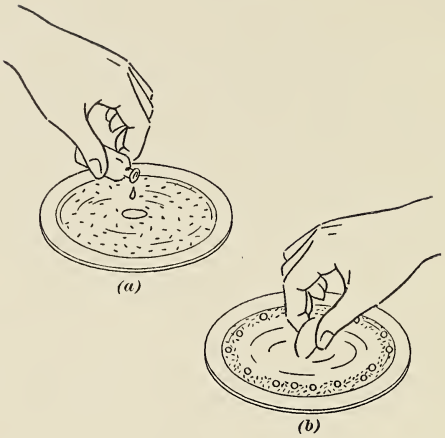
As the gasoline evaporates, the talcum powder will gradually move back over the water surface.



108. A Perfect Circle

a. Make a loop of light *silk* thread and float it on the *clean fresh* surface of a plate of water. Make sure that every part of the thread is on the surface.

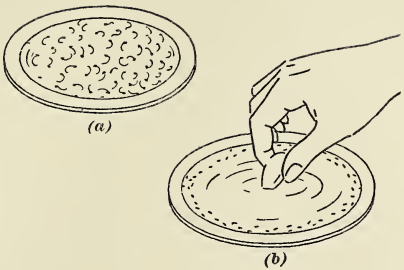
b. Touch a piece of wet soap to the surface inside the loop and the water surface outside the loop will draw the thread out instantly into a perfect circle.



109. Spheres

a. *Rinse the plate thoroughly* and fill it with fresh cold water, sprinkle the surface with a little talcum powder and let one or two dozen drops of kerosene fall on the surface at the center.

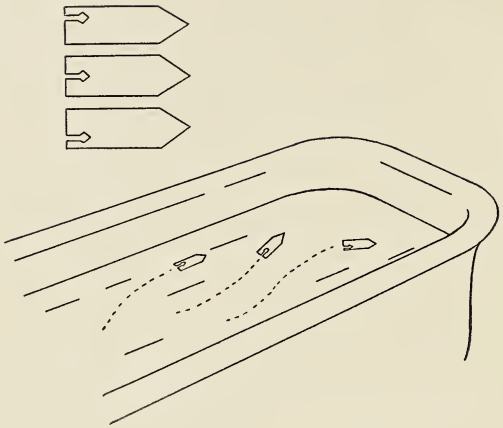
b. Touch the middle of the kerosene patch with a piece of wet soap. The kerosene will be instantly drawn to the edge of the plate where it will gather into small spherical drops.



110. Camphor

a. Buy a piece of camphor at the drug store. Cut off a piece about the size of a half pea. Place this on clean paper and cut it up very, very fine with a clean sharp knife. Drop the crumbs on a plate of *fresh clean* cold water and they will dash about in a lively manner. Do not handle the camphor because oil from your hands will spoil the effect.

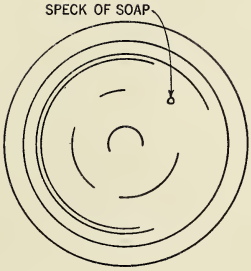
b. Touch a piece of wet soap to the center of the water surface and the camphor particles will be instantly drawn to the edge of the plate and will stop moving.



111. Boats

Cut two or three small boats, about 1 inch long, out of writing paper, and cut a slot and pocket at the stern of each. Place a piece of camphor in each pocket in such a way that it touches the water, but does not fall out.

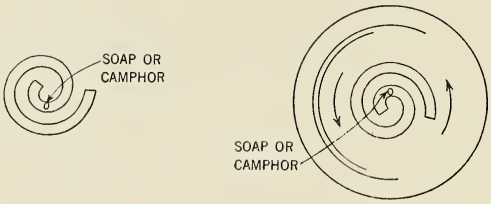
Float the boats in a pail, dish pan or bath tub and they will sail around for a long time.



112. A Speck of Soap

Fill a dinner plate with *fresh* cold water and drop on it a speck of soap about a fourth the size of a pin-head—the smaller the better.

The speck will dash about in a lively manner for a minute or so.



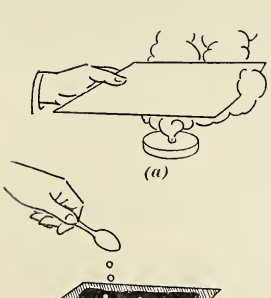
113. Spiral

a. Hold two pencils side by side and draw, on paper or light cardboard, a double spiral about ½″ wide. Cut out the spirals.

Fasten a small sliver of soap or camphor in a slit near the inner end in such a way that it will touch the water but will not fall out.

b. Fill a dinner plate with *fresh* cold water and float the spiral on it.

The spiral will turn rapidly for a short time with soap and slower but for a longer time with camphor.

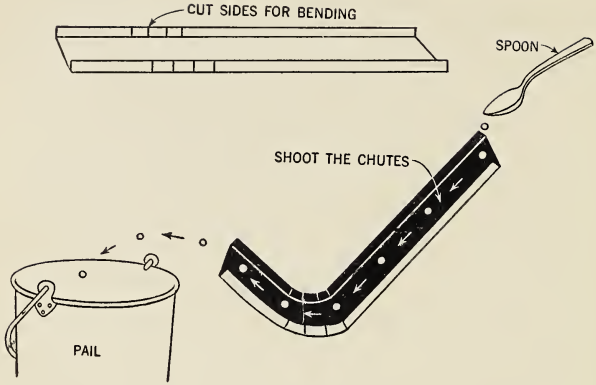


114. Drops

a. Place a small piece of camphor about ½″x½″x½″ on the bottom of an inverted coffee can cover. Cut a piece of wrapping paper 15″x15″.

Light the camphor and move one surface of the paper back and forth rapidly in the smoke of the camphor and as near the camphor as you can, without putting out the flame. Smoke the paper over and over until one surface is very black with soot. Turn up the edges of the paper slightly.

b. Let water from a small spoon fall on the smoked paper and it will form small spherical drops which will roll readily on the smoked paper.



115. Shoot the Chute

a. Cut a piece of wrapping paper 6″ wide and 24″ long. Turn up the long sides 1 inch. And cut these turned-up sides for bending, as shown.

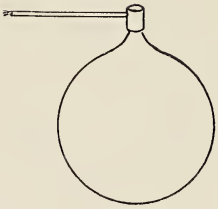
Smoke the inside of this paper thoroughly with camphor, as in the last experience.

b. Arrange a chute, let water fall on its upper end and the drops formed will shoot the chute very rapidly.

116. Spheroidal State

a. Place a coffee can cover over a lighted burner. Dip your fingers into water and shake drops of water into the hot cover. The water will remain as liquid spheres a considerable time.

b. Turn on a water faucet very slightly and notice how the water takes the form of spherical drops.

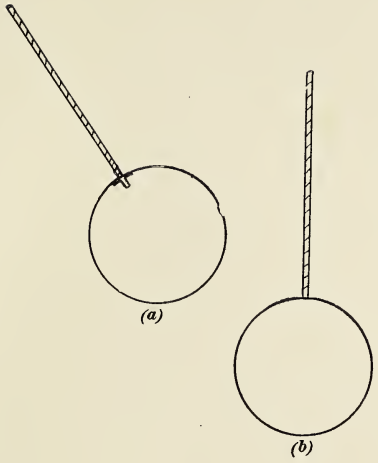


117. The Bubble Contracts

Blow a soap bubble and remove the blower from your mouth.

Notice that the bubble contracts.

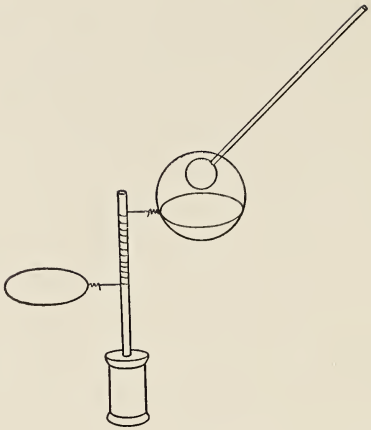
Close the outlet and the bubble will stop contracting; open it and the bubble will contract again.



118. Soda Straw Bubble Blower

a. Cut the end of a soda straw into four slices about ½ inch long and bend the slices outward. Use this to blow bubbles.

b. Use an unchanged soda straw to blow bubbles.

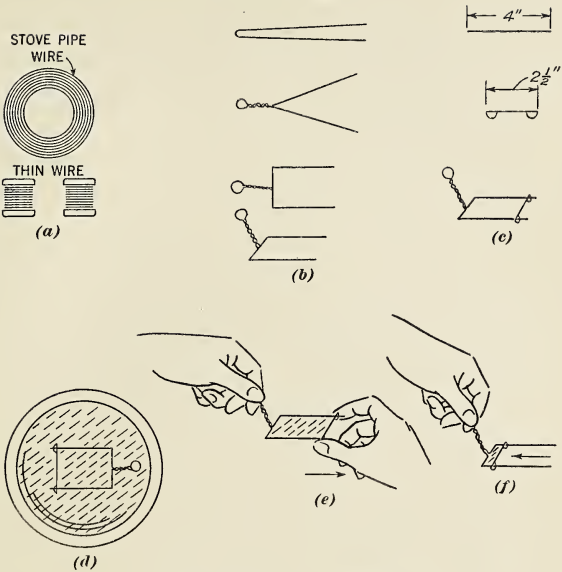


119. Bubble Supports and Double Bubble

Buy iron stove-pipe wire, 50 feet for 5 cents, make circles and attach them to a pencil in a spool, for bubble supports.

Wet a support with soapy water, blow a large bubble and detach it in the support.

Wet a soda straw in soapy water, insert it slowly into the large bubble, blow another bubble and detach it in the large bubble.



120. Fork and Slider

a. Use the iron stove-pipe wire of the last experience, 50 feet for 5 cents, and buy a spool of very thin wire, 2 spools for 5 cents.

b. Cut a 12″ length of stove-pipe wire, double it, and twist the doubled end together for 2″ to make a handle. Make a two tined fork with tines 3″ long and 2″ apart. Bend up the handle and make the tines *parallel*.

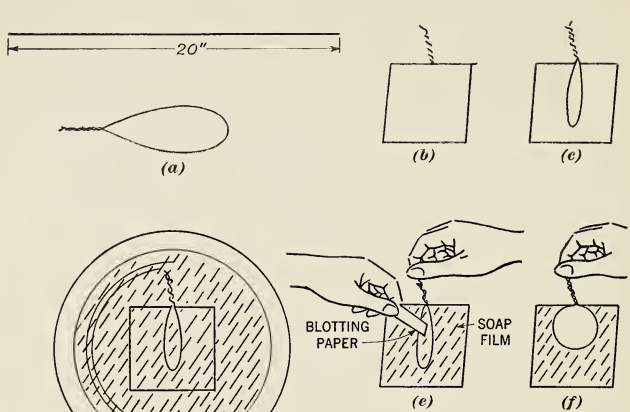
c. Cut a 4″ length of very thin wire and make a slider 2½″ long with a ¾″ loop at each end. Fit the slider over the tines and see that it moves the whole length easily.

d. Fill a dinner plate with thick soap solution and dip the tines and slider under the solution.

e. Lift the fork and get a soap film between the tines and slider. Pull out the slider and the soap film will stretch.

f. Release the slider and the soap film will contract and draw the slider up to the yoke of the fork.

Soap solution. Put three level tablespoonfuls of soap flakes or soap powder into a quart milk bottle, add 4 cups of hot water and let it stand for two or three days. You need a rather thick soap solution for this experience and the next.



121. Square and Loop

a. Cut a 20″ length of stove-pipe wire and twist the ends together for 2″, to make a handle.

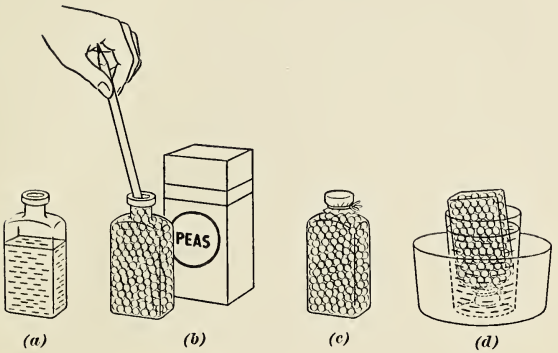
b. Make the remaining 16″ into a square, 4″ on each side, *with the handle at the middle of one side.* Bend up the handle.

c. Cut an 8″ length of *light silk* thread, tie it into a loop $3\frac{1}{2}$″ long and hang it over the handle.

d. Pour thick soap solution into a dinner plate and dip the square and loop under the solution.

e. Lift out the square and loop, one side first, to get a soap film over the square. Touch the soap film inside the loop with a piece of blotting paper.

f. The soap film outside will pull the loop out instantly into a perfect circle.



122. The Peas or Beans Burst the Bottle

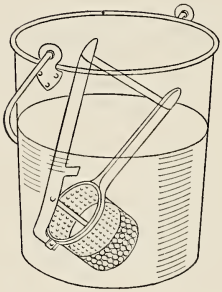
a. Find a four ounce bottle *with flat sides* and fill it three-quarters full of water.

b. Fill the bottle with *dried* peas or beans and ram down the last with a pencil to make sure that the bottle is full to the top with tightly packed peas or beans in water.

c. Tie a cloth securely over the mouth of the bottle.

d. Stand the bottle *upside down* in a tumbler half full of water, and stand them both in a pan.
Inside of 48 hours the peas or beans will burst the bottle.

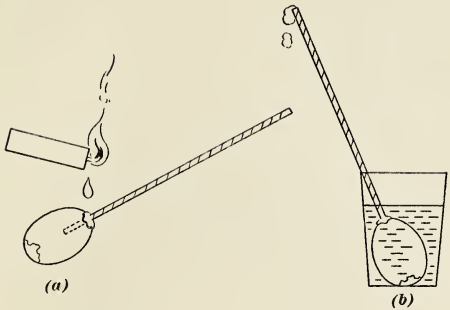
Why? See page 216.



123. The Peas or Beans Break the Cord

Fill a potato ricer one-third full of dried peas or beans. Tie the handles together with a piece of strong cord and put the ricer into a pail of water.

Inside of 48 hours the peas or beans will break the cord.



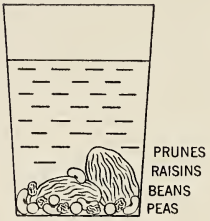
124. The Contents of the Egg Move Uphill

a. At one end of a fresh egg, punch a nail hole large enough to admit a soda straw and pierce the inner membrane.

At the other end, remove the shell from an area of about ¾ square inch but do not break the inner membrane.

Now insert the soda straw about 1 inch into the egg and drop hot candle wax on the joint to make it water tight.

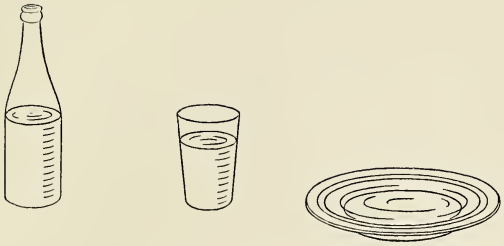
b. Stand the egg in a tumbler of fresh water and in an hour or two you will see the contents of the egg oozing from the top of the straw.



125. Dried Fruits and Seeds Swell in Water

Put 2 dried prunes, 5 raisins, 5 beans and 5 peas into a tumbler of water and observe their condition each day for three days. The fruits and seeds will swell.

This is what happens when seeds are planted in moist ground.

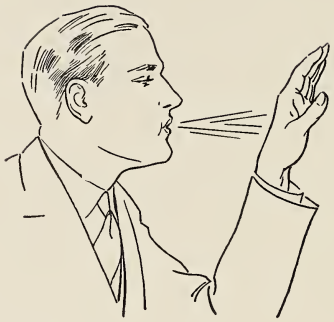


126. Evaporation

Pour a cup of water into an open bottle, another cup into a tumbler and a third into a dinner plate.

Observe the rate of evaporation daily.

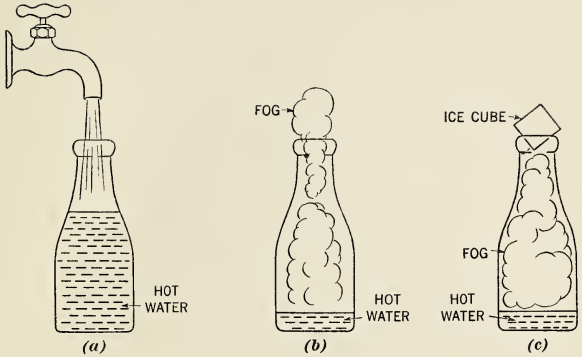
The larger the surface the more rapid the evaporation.



127. Cooling by Evaporation

Blow on the back of your hand and it will feel cool.

Moisten the back of your hand and blow on it. It will feel cooler.



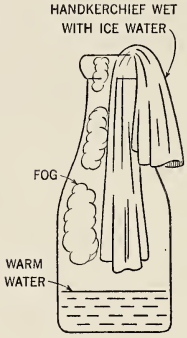
128. Fog

a. Fill a milk bottle with hot water and empty it except for one inch in the bottom.

b. Hold it up to the light and you will see thin streams of fog rising from the bottle.

c. Put an ice cube in the mouth of the bottle, hold the bottle up to the light and you will see thin streams of fog moving down into the bottle.

Fog is formed in nature when warm moist air is cooled by cold air or otherwise.

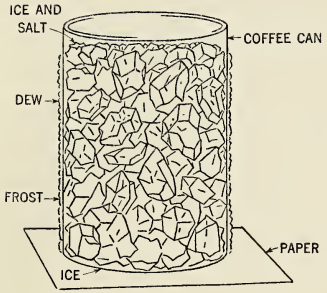


129. Fog and Cloud

Prepare a quart milk bottle as in the last experience.

Dip a handkerchief, or similar cloth, into ice water, wring it out slightly and hang it in the bottle. You will see thin fog in the bottle.

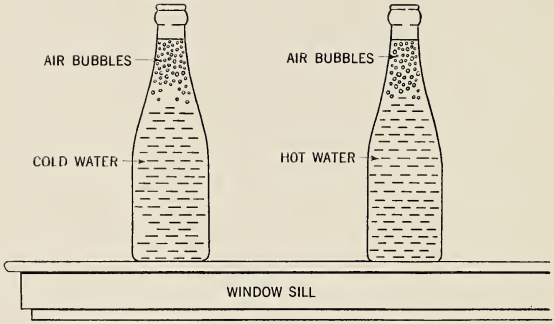
A *cloud* is fog above the surface of the earth, or fog is a cloud on the surface of the earth.



130. Dew, Frost and Freezing

Put cracked ice in a coffee can and stir it with about one-third its volume of salt. Pour a half teaspoon of water on a piece of paper and stand the can on the wet paper.

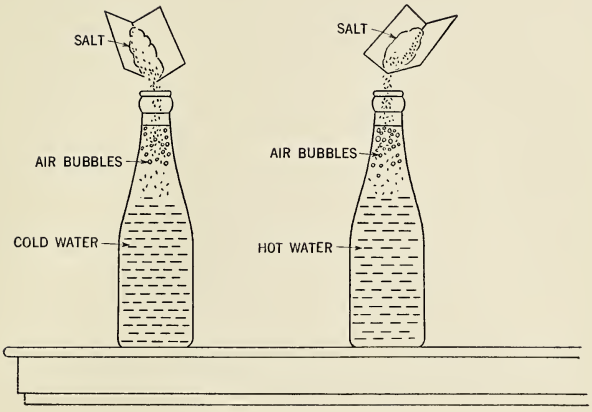
You will see dew and frost form on the side of the can and the paper frozen to the bottom of the can.



131. Air in Water

Fill one quart soda bottle from the cold water faucet and another from the hot water faucet. Stand them on a window sill.

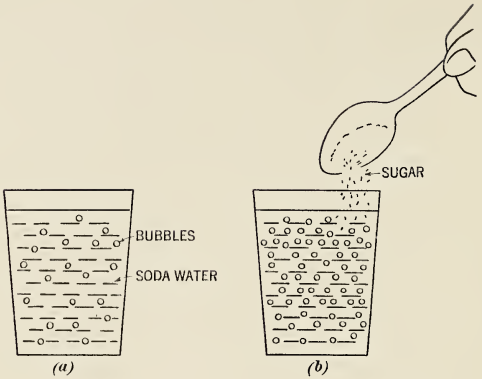
Look at the water near the top and you will see millions of tiny air bubbles rising in the water.



132. Salt Drives Out Air

When the air bubbles have stopped rising in the last experience, pour a heaping tablespoonful of table salt into each bottle. Cover and turn each upside down once to mix the salt and water.

You will see many more air bubbles rising in the water.



133. Sugar Drives Out Gas

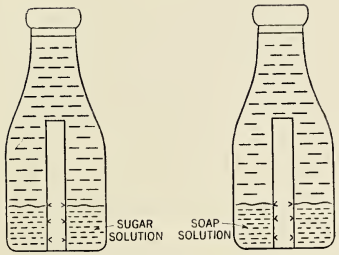
Soda water is carbon dioxide gas dissolved in water, with some flavoring matter.

a. Pour out a glass of soda water and look at it.

You will see many bubbles of carbon dioxide gas.

b. Pour a heaping teaspoonful of sugar into the soda water and stir it.

You will see the gas bubbles form very rapidly.

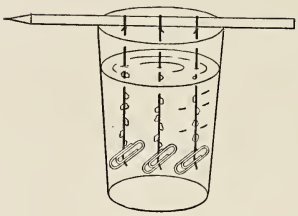


134. Diffusion

Paste a strip of paper up the side of each of two quart milk bottles. Fill the bottles with water. Drop into one four large lumps of sugar and into the other four lumps—about the size of the sugar lumps—of soap which sinks. Cap the bottles and stand them in a quiet place.

The sugar dissolves in the water and forms a heavy solution which diffuses upward very slowly. The soap acts in a similar manner.

Mark on the paper each week the height of each solution and the date.



135. Crystals

Buy five cents worth of alum, dissolve it in hot water and pour the solution into a tumbler.

Fasten a paper clip to the lower end of each of three strings and hang the strings in the solution from a pencil above the tumbler.

Observe the solution each day and you will see crystals of alum forming on the strings and at the bottom of the tumbler.

Try this also with table salt, Epsom salt and saltpeter.

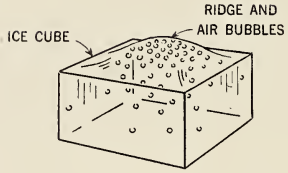
136. Invisible Ink

Make a concentrated solution of table salt in hot water and let it cool.

Write your name with this salt solution with a new clean pen which has never touched ink.

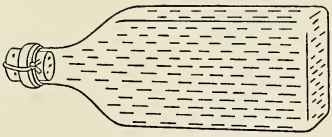
Let the writing dry and it will be almost invisible.

Rub across it with a lead pencil and your name will appear.



137. Water Expands on Freezing

Examine an ice cube. It is bulged at the center because the water expands on freezing. Note also that the air bubbles are most numerous at the bulge. The ice crystals in forming tend to drive out the air.



138. The Ice Bursts the Bottle

Find a four ounce bottle with *flat* sides.

Fill it with water and let it stand until the air bubbles escape.

Insert the cork firmly and *tie it in.*

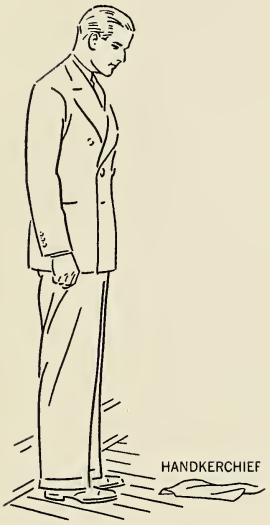
Place the corked bottle over night in an empty ice cube tray in the ice cube space of a refrigerator.

You will find the bottle broken in the morning.

139. Ice Evaporates

Wet a towel, wring it out and hang it outside to dry on a day *in winter* when the temperature is *below freezing.*

The water freezes to ice yet you will find the towel nearly free from ice next day.



140. Heels and Shoulders Against the Wall

Stand with your heels and shoulders against the wall.

Drop a handkerchief on the floor about a foot from your toes and try to pick it up without moving your feet.

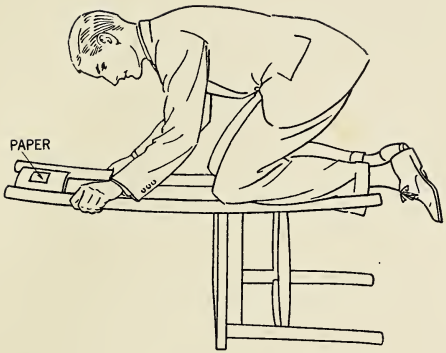
You will find you can not do it.

Why? See page 219.

141. Back Horizontal

Place a chair near the wall. Bend over it with your head against the wall and with your feet far enough away from the wall to make your legs, from heels to hips, slant toward the wall. Lift the chair from the floor and then try to straighten up without moving your feet.

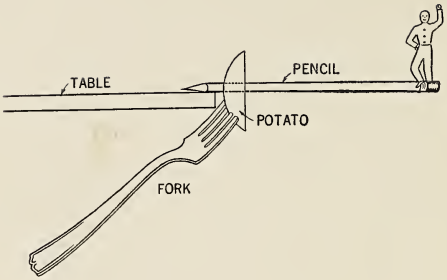
You will find you can not do it.



142. Chair Back

Use a stout chair as illustrated and try to pick up the paper with your lips.

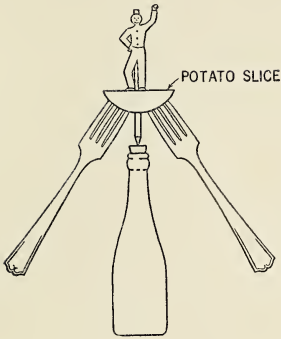
You will find it hard to do.



143. Potato Pencil and Fork

Cut a slice of raw potato one inch thick. Drive the point of a pencil through it about one inch, attach a light cardboard man to the rubber end of the pencil. Insert the fork, and balance the device on the corner of a table.

Give the pencil a slight push downward and the man will bob up and down.

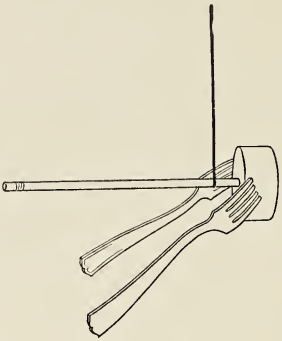


144. Potato, Pencil and Forks

Cut a slice of raw potato about one inch thick.

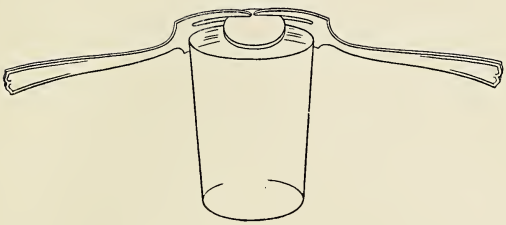
Drive a pointed pencil through it for a distance of about one inch. Cut a little man out of paper and fasten him to the upper part of the pencil. Insert two forks and balance the pencil point on a cork in a soda bottle.

Give the pencil a twirl and the device will spin merrily.



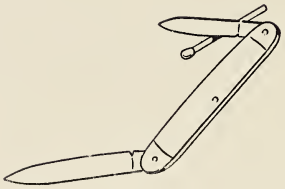
145. Potato, Pencil and Forks

Insert into a slice of potato the point of a pencil and the tines of two similar forks; then suspend them as illustrated. They will balance.



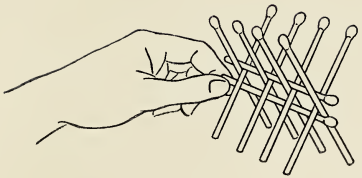
146. Forks and Fifty-Cent Piece

Insert a fifty-cent piece between the first and second tines of two similar forks and balance the group on the edge of a tumbler.



147. Knife and Match

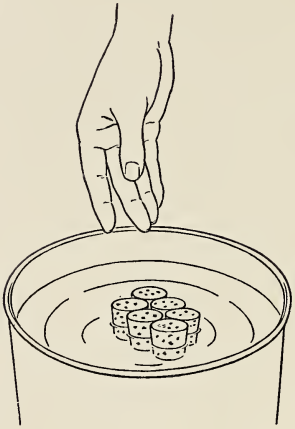
Balance the knife as illustrated.



148. Matches

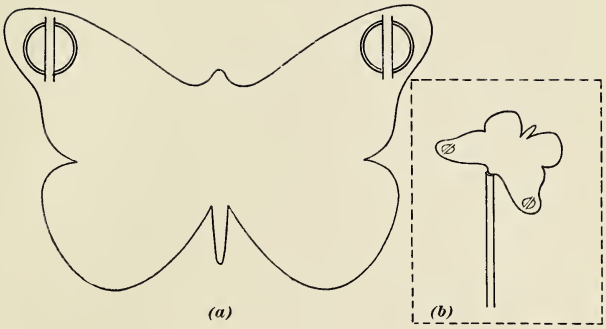
You can lift many matches with one, as illustrated.

Use large kitchen matches, pile them on the table in the order shown and lift them with the lowest match.



149. Corks

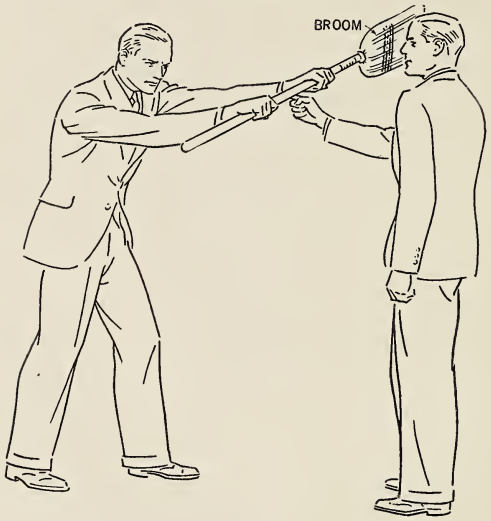
Try to float upright one cork, two corks, three corks, and so on.



150. Butterfly

a. Cut a butterfly about 6″x3″ out of cardboard. Insert a penny in a cut near the forward end of each wing. Make sure that the middle of each penny is slightly in front of the head of the butterfly.

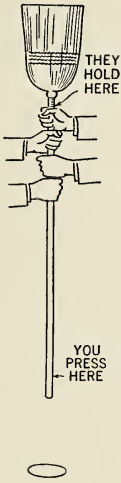
b. Place the head of the butterfly on the rubber end of a lead pencil or on the corner of a table, and the butterfly will balance.



151. He Can't Shove You Over

Let a friend hold a broom handle horizontally at arms' length with both hands, while you stand opposite him with one finger under the handle.

Let him move forward about 1 foot to shove you over. He can not do so if you simply lift up on the handle.

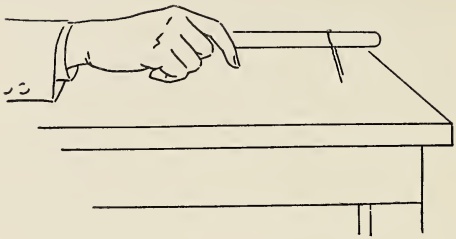


152. They Can't Hit the Circle

Draw a circle four inches in diameter on the floor. Let two friends hold a broom handle vertically at arms' length with their hands close together near the broom-straw end.

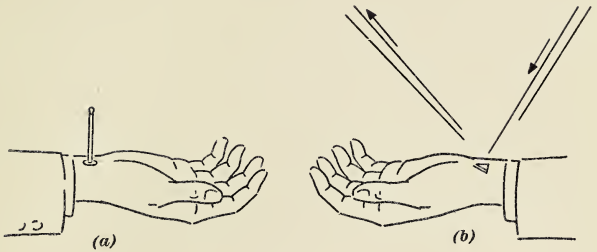
Let them hold the end of the handle one foot above the circle and try to move it downward to hit the circle.

They cannot do so if you sit on the floor and move the end sidewise with a little finger.



153. Knife and Hair Pin

Hold a table knife in a horizontal position, place a hair pin on the blade and, without resting your hand or arm on the table, lower the knife horizontally until the ends of the hair pin rest on the table. The hair pin will slide along the blade. Try two hair pins.



154. Your Pulse

a. Stick a match on the point of a thumbtack. Stand the head of the tack on your pulse and the head of the match will bow solemnly each time your pulse beats.

b. Use a pair of pliers to break a triangle about $\frac{1}{4}'' \times \frac{1}{4}'' \times \frac{1}{2}''$ from the corner of a five-cent mirror. Place this mirror on your pulse and hold your arm in strong sunlight.

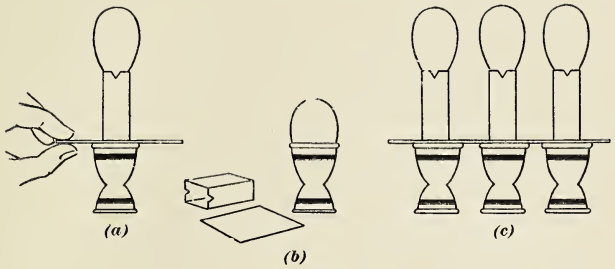
The spot of sunlight reflected to the wall or ceiling will move 6″, more or less, each time your pulse beats.

155. A Trick

Place a cent or dime on the back of your hand just over the upper knuckle of your little finger. Place the end of the little finger *under* the thumb. Flick the thumb away from the little finger and you will turn the coin over, with a little practice.

Ask your friends to try this. Most of them will fail because they will put the little finger *above* the thumb.

Inertia



156. Egg and Egg Cup

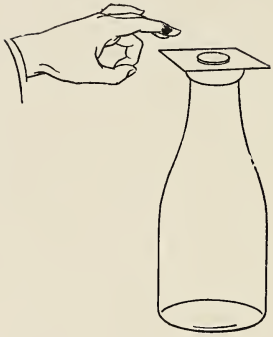
a. Balance a hard-boiled egg on a match box on a piece of cardboard on an egg cup. Use only the outer part of the match box and cut notches to hold the egg upright. Be sure that the center of the egg is exactly over the center of the cup.

b. Jerk the cardboard out horizontally and the egg will drop into the cup.

c. Similarly use three eggs on three match boxes on a single piece of cardboard on three egg cups.

Jerk the cardboard out sidewise and each egg will drop into a cup.

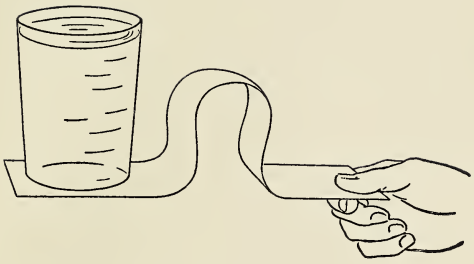
Why? See page 220.



157. Coin, Card and Bottle

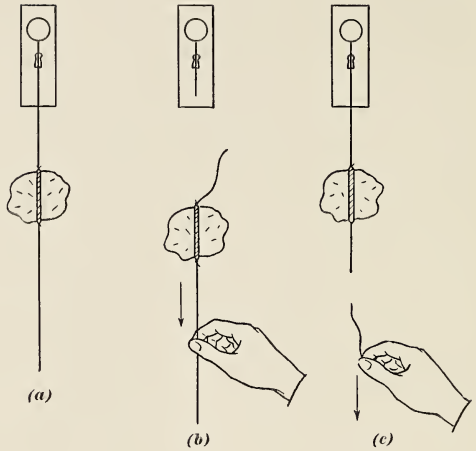
Place a coin on a card over the mouth of a milk bottle. Flick the card horizontally and it will fly out.

The coin will not move horizontally but will simply drop into the bottle.



158. Tumbler and Paper

Place a tumbler full of water on the end of a long strip of paper. Move the paper slowly and the tumbler will move with it. Jerk the paper and the tumbler will stand still.

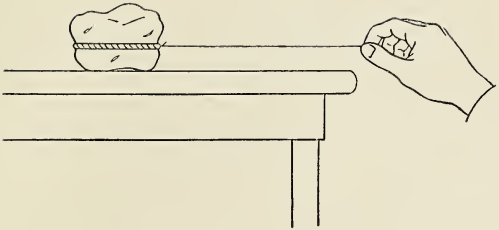


159. Rock and Cord

a. Find a piece of rock weighing about 2 lb. Tie a heavy cord around it and tie to this two lighter cords *of the same strength,* one above and the other below the rock. Tie the upper cord to a door knob or other support.

b. *Pull slowly* downward on the lower cord and the *upper* cord will break.

c. *Jerk quickly* downward on the lower cord and the *lower* cord will break.



160. Rock and Thread

Attach a thread to the rock and lay the rock on the table.

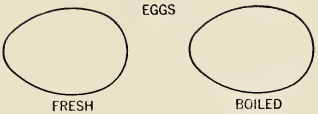
Pull gently on the thread and the rock will move.

Jerk quickly on the thread and the thread will break but the rock will remain still.

161. Coins

Pile a number of similar coins (nickels) one on another.

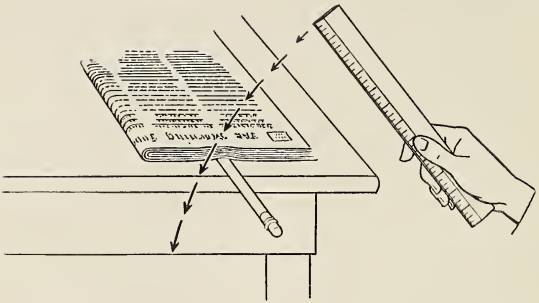
Flick a thinner coin (cent) at the bottom coin. The bottom coin will fly out and leave the remaining coins in a pile.



162. Eggs

Spin a fresh egg on its side and it will stop quickly. Spin a hard boiled egg and it will continue to turn for a much longer time.

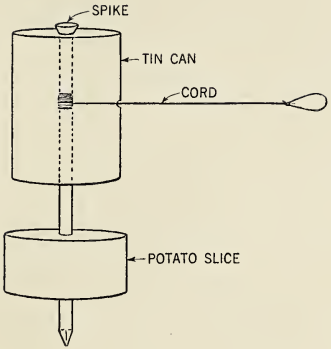
NOTE: If the fresh egg has been in a refrigerator, let it warm to room temperature before you try this experience. The liquid inside a fresh egg is stiff when cold.



163. Break a Pencil

Place a lead pencil at the edge of the table with one half projecting and with the other half under a folded newspaper.

Hit the exposed half smartly with a heavy ruler and the pencil will break without tearing the newspaper.



164. Tin Can Spinner

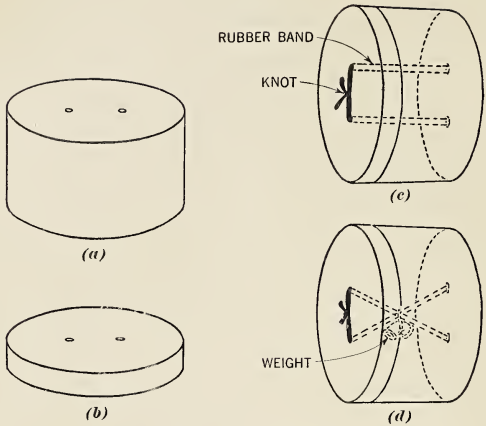
Use a long spike to punch a hole through the cover and bottom of a *small* can. Enlarge the hole so that the spike will turn easily.

Punch a hole in the side of the can and turn back the rough edges.

Cut a thick slice out of the middle of a potato. Mark a circle on it and cut the slice to the shape of a circle. Put the spike through the center of this circle.

Pass one end of a cord through the hole in the side of the can, and tie it to the spike inside. Turn the spike to wind up the cord.

Hold the can and pull the cord at the proper intervals to revolve the spike and potato first in one direction and then in the other.



165. Come Back

a. Find a squat one pound coffee can. Punch two nail holes in the bottom on opposite sides of the center and ¾ inches from it.

b. Punch two similar holes in the cover.

c. Find a rubber band *⅛ inch wide and 3 inches long.* Cut it at one end, pass it through the holes and tie it above the cover. *Be sure to use a rubber band of the size mentioned above.*

d. Tie a weight (a one-inch iron elbow) firmly to the middle of *both* lengths of the band.

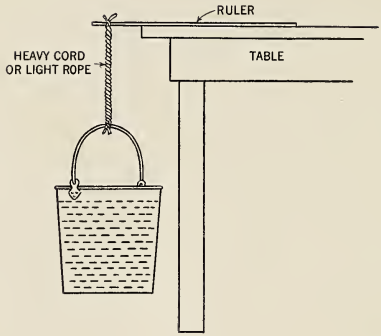
e. Roll this can 30 feet along a *smooth* floor and it will roll back to you.

166. The Water Does Not Spill

Fill a small pail nearly full of water and practice swinging it at arms' length.

Finally swing it over your head in a complete circle without spilling a drop.

Try this also with a tumbler half full of water.



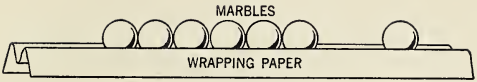
167. Circular Fountain

Support the pail on a double heavy cord or double light rope of such length that the bottom of the pail is about two inches above the floor. Fill the pail with water to within one inch of the top.

Turn the pail to twist the rope *as far as it will go.*

Let go the pail and the rope will twirl the pail and water very rapidly. The water will gradually sink at the middle and rise up along the inner side of the pail. When it reaches the top it will overflow and sprinkle the floor in a circle.

Marbles



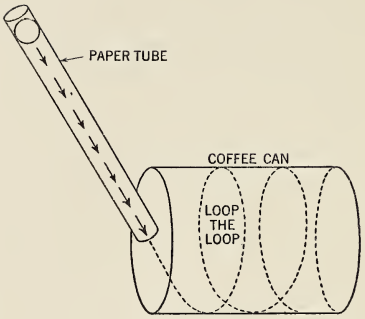
168. Marbles

Cut a strip of heavy wrapping paper 3 feet long and 3 inches wide. Fold it carefully in half lengthwise and then fold *back* each side in half.

Make this into an M shaped trough and place 8 or 10 marbles side by side and touching in the trough.

Roll one marble against the row, and the marble at the other end of the row will shoot out but the rest will remain still.

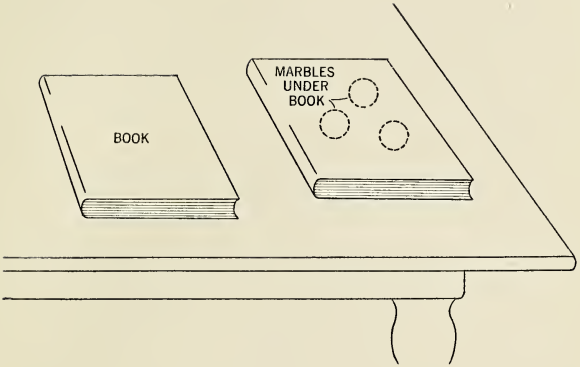
Roll two marbles against the row and the two at the other end will shoot out. Repeat with 3 and 4 marbles.



169. Loop the Loop

Make a paper tube 2 feet long, and large enough to let the marble roll through freely. Hold the lower end of this against the inner side of the open end of a coffee can turned on its side.

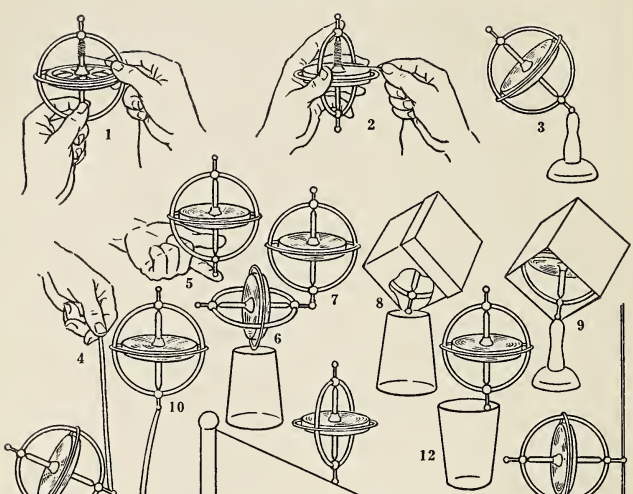
A marble dropped into the top of the tube will loop the loop once or twice inside the can.



170. Ball Bearings

a. Place a book on the bare table and give it a push sidewise.

b. Now put three marbles under the book and push it again. The marbles (ball bearings) let the book move easily.



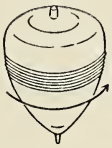
171. Gyroscope

Thirteen experiences with the gyroscope are shown above.

The gyroscope appears to defy the law of gravitation. You can see why it does as follows: spin the gyroscope as in 1 and notice the direction the wheel is revolving, then turn it upside down and notice that the wheel is revolving in the *opposite* direction.

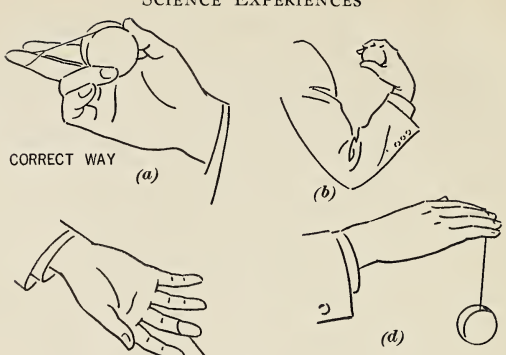
To turn the gyroscope over you must do work equal to that required to stop the wheel spinning plus the work required to spin it with equal speed in the opposite direction.

The gyroscope does not fall over until the work necessary to stop it spinning is done by friction of the air or at its bearings.



172. Top

It appears to defy the law of gravitation for the reason given in the last experience.



173. Yo-Yo

The loop projecting from the groove should be made into what is known as a slip-knot and then placed around the middle finger at the first joint.

Turn the palm of the hand upwards, as shown in *a.*, not downward, and allow the top to fall over the end of the finger, as indicated in *b* and *c*.

When the Yo-Yo falls within about 3″ to 6″ of the bottom, raise the hand slightly at the same time turning the palm downward to receive Yo-Yo as it approaches your hand, as indicated in *d*.

Then you will see Yo-Yo climb the string like a squirrel. The action is similar to the bouncing of a rubber ball.

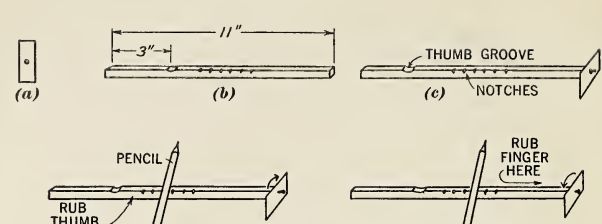
If unsuccessful, rewind the string loosely in the groove of the Yo-Yo until the string has taken hold, then wind more firmly until it is all wound up.

Then repeat as before, until you have mastered the first trick of making the toy race up and down the string.

If the Yo-Yo does not come all the way back to the hand the first few times, do not grab for it, but continue the motion of raising and lowering the hand until successful in making it return by its own accord to the hand.

174. Rotating Disk

Cut a circular disk out of cardboard. Punch two holes on opposite sides of the center and equal distance from it. Loop a long cord through the holes, twist it, and pull out on its ends at intervals. The disk will spin rapidly first in one direction and then in the other.



175. Fortune Teller

a. Make a wooden propeller about 2″ × ¾″ and make a hole at its middle.

b. Make a wooden handle about 11″ × ⅜″ × ¼″. Cut a shallow thumb groove 3″ from one end and six notches, ½″ apart starting 4½″ from the same end.

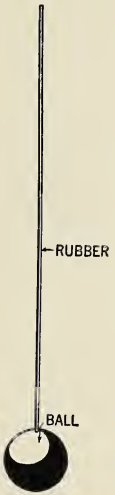
c. Nail the propeller to the other end, being sure that the hole is considerably larger in diameter than the nail.

d. Hold the stick in the left hand with the left thumb in the groove. Hold a pencil in the right hand, rub it in the notches and at the same time rub the right *thumb* hard on the *side* of the stick. The propeller will turn as shown.

e. Rub the pencil in the notches and at the same time rub the right *forefinger* hard on *top* of the stick, the propeller will revolve in the opposite direction to that in *d*.

You can pretend to answer any question in fortune telling by taking a revolution in one direction to mean "yes" and in the opposite direction, "no."

Of course, do not tell how you use your right thumb and forefinger.



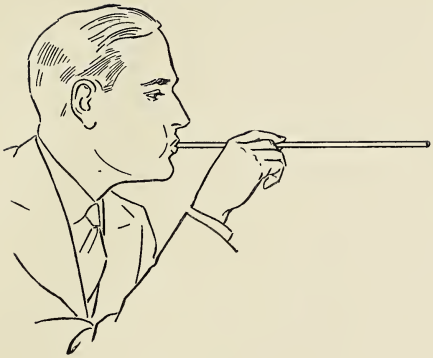
176. Ball and Elastic

You are familiar with the use of this device. It is an excellent illustration of elasticity.

177. Pop-Pop Boat

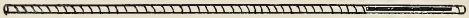
Fill the boiler with water, light the candle under it and place the boat in a circular dish pan filled with water *to the top.*

The boat will sail around merrily with a pop-pop sound.



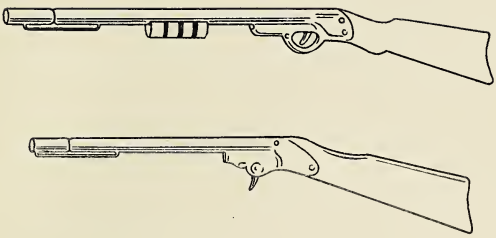
178. Pea Shooter

This is an excellent example of the use of compressed air.



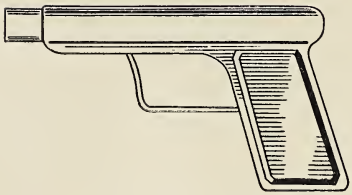
179. Soda Straw Air Gun

Put a match inside a soda straw and you have an excellent air gun.



180. Pop Guns

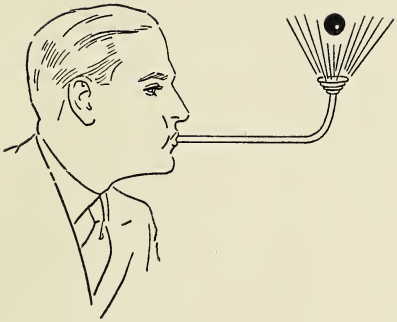
The noise from these is made by the sudden release of air compressed by a plunger.



181. Water Pistol

Pull the trigger, put the nozzle into water and release the trigger. The pistol loads with water.

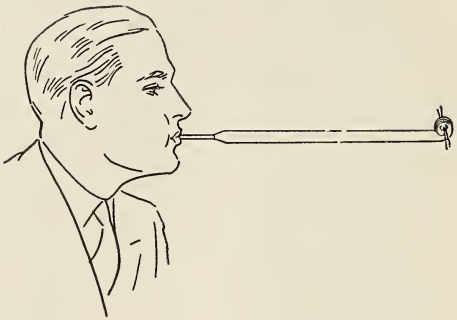
Pull the trigger again and the air pistol shoots out a fine stream of water.



182. Balancing Ball

Blow into the tube and the ball remains suspended in the air stream.

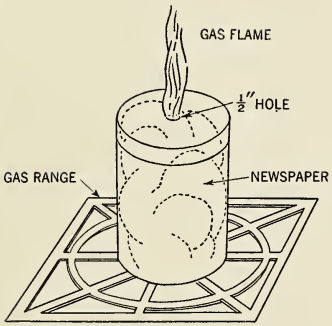
See also experiences 43 to 48.



183. Tickler

Blow into this long paper tube and the air you compress inside will uncoil it.

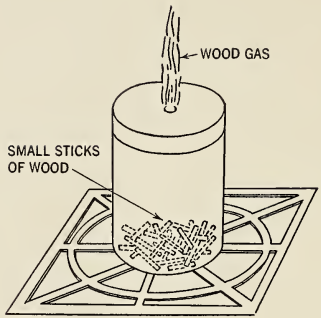
Release it, and a strip spring along one side will coil it up again.



184. A Gas Plant

Use a scissors with closed blades to punch a half inch hole at the middle of the cover of a coffee can. Crumple a page of a newspaper in the can, put on the cover and put the can *over the fire* in a range. After the water vapor has been driven off light the gas which issues from the hole. After the gas has all burned, let the can cool and examine the paper charcoal.

NOTE: The can must be in contact with the burning wood or coal or gas; or over the hot electric coils in the range.



185. To Make Wood Gas, Creosote and Charcoal

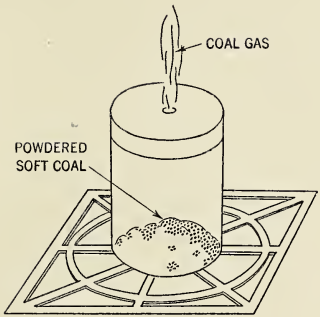
Cut wood into short narrow sticks, put a handful or two into the can and heat the can over the fire in a range.

After the water vapor has been driven off, light the wood gas which issues from the hole in the cover.

After the gas has all burned, let the can cool and examine the charcoal left in the can. This is excellent for charcoal drawings.

Smell the inside of the cover. The odor is that of creosote.

Charcoal will burn with little flame or smoke.



186. To Make Coal Gas, Coal Tar and Coke

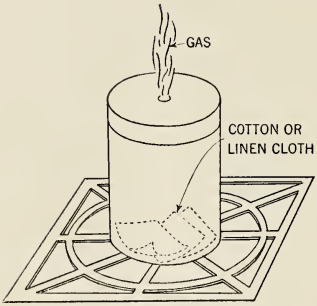
Put four heaping teaspoonfuls of broken *soft* coal into the coffee can and heat the can *over the fire* in a range.

After a time light the coal gas which issues from the hole in the cover.

After the gas has all burned, let the can cool and examine the coke left in the can.

Notice the black liquid on the inside of the cover, and smell it.

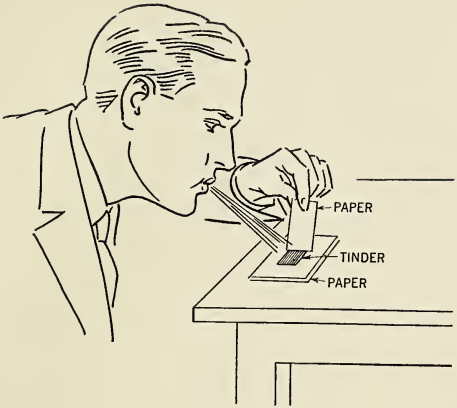
This is the coal tar from which we obtain beautiful aniline dyes.



187. To Make Tinder

Place 4″×4″ pieces of cotton or linen cloth in a can and heat it until gas stops coming out of the hole. Let the can cool and you have pieces of cotton or linen charcoal, which make excellent tinder. Store it in a dry air tight box and it will keep a long time.

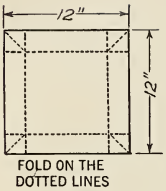
NOTE: The gas ignites easily and may blow the cover off the can. If so, just put it on again quickly.

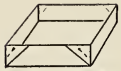


188. To Use the Tinder

Place it on a piece of paper and hold it with another piece of folded paper. Light it with a flint and steel and blow on it to light the paper.

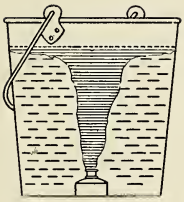
NOTE: You can buy a flint and steel for 15 cents.





189. To Boil Water in Paper

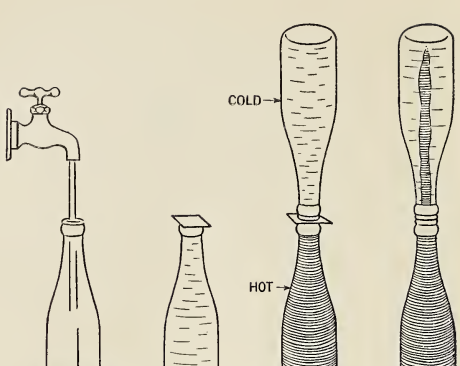
Make a paper box out of smooth wrapping paper as above, place it over a burner, fill it half full of water and light the gas. The water boils but the paper does not burn.



190. Hot Water Volcano

Pour a teaspoonful of ink into an empty ink bottle. Fill the bottle with *hot* water and cork it.

Place the bottle in a pail full of *cold* water and remove the cork carefully. The black colored hot water will rise to the surface. It looks like a volcano.



191. The Genie

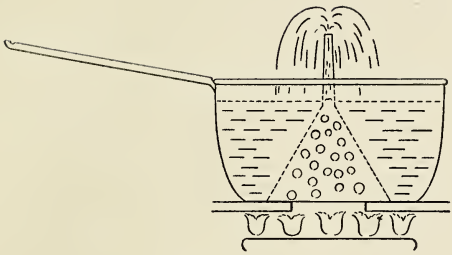
a. Pour two tablespoonfuls of ink into a soda bottle and fill the bottle with *hot* water.

b. Fill a similar bottle with cold water.

c. Cover the cold water bottle with $1\frac{1}{2}'' \times 1\frac{1}{2}''$ piece of wrapping paper and press the paper down hard with your thumb to squeeze out a little of the water.

d. Invert the cold water bottle and place its paper covered mouth over the mouth of the hot water bottle.

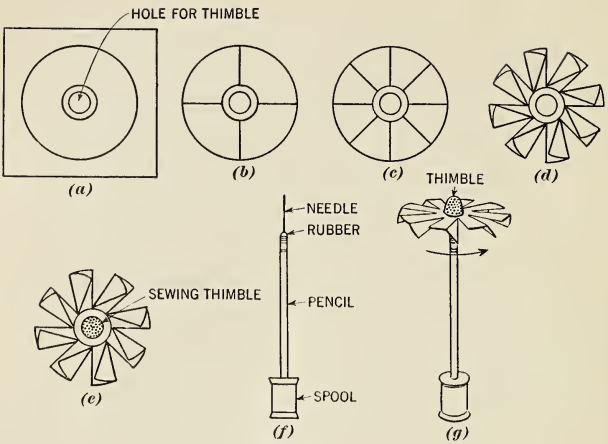
e. Slide the paper out carefully and the colored hot water will rise into the upper bottle. It will remind you of an Arabian Nights genie emerging from its bottle.



192. Percolator

Invert a large tin funnel in a saucepan and pour in water until its surface reaches part way up the stem of the funnel.

Boil the water and the funnel will "perk" enthusiastically.



193. Hot-Air Wheel

Make a hot-air wheel, as follows:

a. Draw on writing paper a circle 2½″ radius and cut it out. Draw another circle of ½″ radius. Place a sewing thimble inside the ½″ circle and draw around it. Cut out a slightly smaller circle to fit the thimble.

b. Cut from outer circle to inner circle at the quarter circle.

c. Cut from circle to circle between the above.

d. Bend half of each slice back.

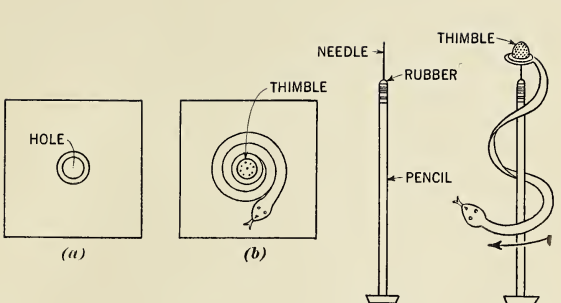
e. Insert the thimble into the center hole.

f. Tie a needle to the rubber end of a lead pencil and place the point of the pencil in a spool.

g. Bend each wing at an angle of 45° to the top. Put the end of the needle through the hole in the center and let it rest on the inside of the top of the thimble.

Place this wheel over a hot radiator and it will spin merrily.

If the radiators are not hot, hold a lighted match near the spool under the wheel and the wheel will spin merrily.



194. Hot-Air Serpent

Make a hot-air serpent as follows:

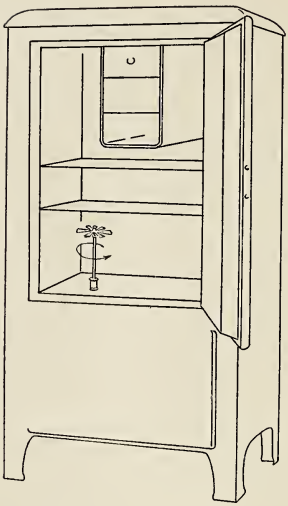
a. Place a thimble on a piece of writing paper about 6″×6″ draw around it and cut a slightly smaller hole for the thimble.

b. Draw a spiral serpent around the thimble hole and cut out the serpent. Put in eyes and nose.

c. Make a support as in the last experience.

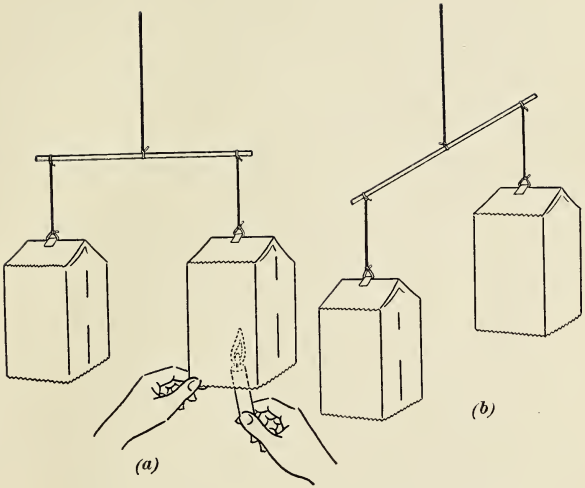
d. Insert the thimble and support the serpent.

Place this air serpent over a hot radiator and it will spin merrily, or hold a lighted match under it.



195. Cold-Air Current

Place the hot-air wheel or serpent under the cooling unit in a refrigerator, close the door of the refrigerator to let the air currents become steady, then open the door very slightly and you will see the wheel or serpent revolving in the cold downward air current, in a direction *opposite* to that in a hot upward air current.

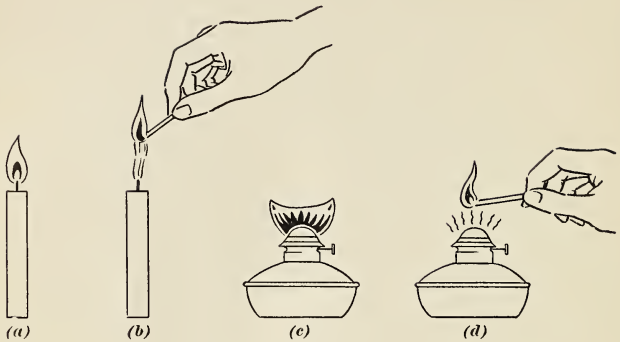


196. Hot Air Is Lighter Than Cold Air, Volume For Volume

a. Balance a stick on a cord attached to a support and balance two similar paper bags *up-side-down* near its ends.

Hold one bag and heat the air in it with a lighted candle.

b. Remove the candle and the bag will rise when it is released.



197. To Light a Candle or Lamp Without Touching the Wick

a. Light a candle and let it burn a minute or two.

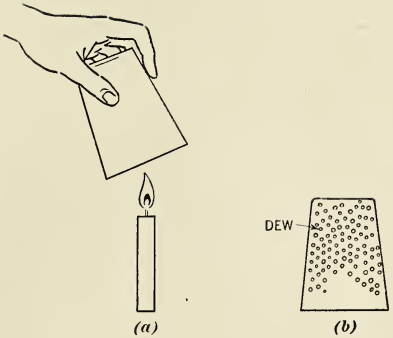
b. Blow it out and bring a lighted match down quickly into the smoke.

The wick will light before the match touches it.

c. Light a lamp and let it burn a minute or two.

d. Blow it out and bring a lighted match down quickly into the smoke.

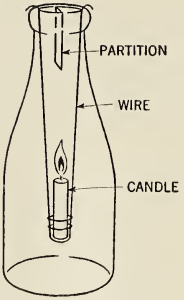
The wick will light before the match touches it.



198. To Get Water From a Flame

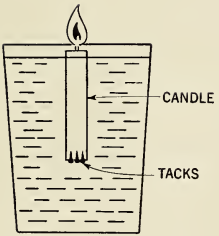
a. Hold a *cold* tumbler for two seconds upside down over the flame of a candle, oil lamp or gas burner.

b. Remove it and you will find water, dew, on the inside of the tumbler.



199. Candle Lantern

Support a candle on a wire frame in a milk bottle, and arrange a cardboard partition in the neck of the bottle to separate the cold and hot air currents. Light the candle and you have a lantern which will stay lighted in almost any wind.



200. A Safe Night Light

Fill a tumbler with water to within ¼ inch of the top.

Shove a sufficient number (2 or 3) tacks into the bottom of the candle to make it float upright in water. Place the candle in the tumbler, light it, and let it burn. The candle will rise as it burns and becomes lighter.

EXPLANATIONS

Atmospheric Pressure

The atmosphere of the earth is attracted by the earth and hence it has weight.

It exerts a pressure of 14.7 pounds (nearly 15 pounds) on each square inch of everything at the earth's surface. It exerts this pressure equally in all directions, upward, downward and sidewise, at any given place. We will call this pressure 15 pounds per square inch, for convenience.

The air in a bottle, or other vessel, open to the atmosphere, also exerts a pressure of 15 pounds per square inch.

If, however, part of the air is removed from the bottle, the air remaining has proportionally less pressure. If, for example, $\frac{1}{3}$ the air is removed, the remaining $\frac{2}{3}$ has a pressure of $\frac{2}{3} \times 15$ or 10 pounds per square inch.

If, on the other hand, the air in the bottle is increased, its pressure is increased proportionally. If, for example, $\frac{1}{3}$ more air is forced into the bottle, its pressure becomes $\frac{4}{3} \times 15$ or 20 pounds per square inch.

1—The heat of the burning paper expands the air in the bottle and thereby forces about two-thirds of it out of the bottle. When the remaining one-third cools and contracts, its pressure is only about 5 pounds per square inch.

The atmosphere outside forces the egg into the bottle against this low pressure.

This experience is sometimes explained by saying that the burning paper uses up the oxygen in the bottle and thereby produces the low pressure. This is only a small part of the cause.

The carbon and hydrogen in the burning paper do unite with the oxygen of the air in the bottle and produce carbon dioxide gas and water vapor. They do use up the oxygen but they replace it by an equal volume of the two gases: The carbon dioxide gas remains a gas but the water vapor condenses to liquid water and thereby aids somewhat in producing the low pressure.

The chief cause of the low pressure, however, is the expansion of the air by the heat of the burning paper.

2—Air blown into the bottle passes around the egg and increases the air pressure in the space above the egg. This increased air pressure shoves the egg out.

3—Similar to 1.

4—Similar to 1.

5—The heat of the candle flame expands the air and forces part of it out of the bottle. The flame goes out when it has used up the oxygen and the air left in the bottle then cools and contracts. This decreases the air pressure in the bottle and the atmospheric pressure on the water surface in the pan forces water up into the bottle. The candle is lighter than water volume for volume and is floated up by the water.

6—The heat of the burning paper forces out about ⅔ the air in the sealer as in 1 and thereby reduces the pressure of the remaining air to about 5 pounds per square inch. The pressure of the atmosphere is 15 pounds per square inch and the difference is 10 pounds per square inch.

Since the area of the cover is about 7 square inches you must exert a force of over $10 \times 7 = 70$ pounds to lift the cover.

7—*a.* The upward force of the atmosphere on the under side of of the paper is greater than the downward force of the water on the upper side of the paper and therefore the atmosphere holds the paper on the tumbler.

b. The atmosphere presses on the thin film of water, between the rim of the tumbler and the table top, and holds the water in the inverted tumbler.

8—The atmosphere presses on the thin film of water between the tumbler rims and holds the water in the inverted tumbler.

9—The atmosphere presses down on the water surface in the tumbler and stops the out flow of water as soon as the water surface reaches the mouth of the bottle.

The downward force of the air let into the bottle is less than that of the atmosphere outside. It becomes equal to the force of the atmosphere only when the water level inside the bottle is the same as that outside.

10—*a.* The steam fills the can and drives nearly all the air out of the can.

b. The steam condenses to water and leaves nearly a complete vacuum in the can which exerts practically no pressure outward. The atmosphere outside exerts a pressure inward of 15 pounds on each square inch and crushes the can.

c. The steam pressure inside forces the sides of the can outward.

11—The steam drives the air out of the bottle and leaves a vacuum (nearly) when it condenses.

The atmosphere presses down on the surface of the water in the pail and forces the water into the bottle.

You use *warm* water to avoid cracking the bottle.

12—Similar to 11.

13—As in 1, the pressure of the air in the bottle is reduced to about 5 pounds per square inch and this is the pressure on the part of the balloon covered by the mouth of the bottle.

The pressure of the atmosphere on the balloon outside the bottle, 15 pounds per square inch, forces part of the balloon into the bottle.

14—The pressure of the air in the bottle is reduced to about 5 pounds per square inch and this is the pressure on the part of your palm covered by the mouth of the bottle.

The pressure of the atmosphere on the remainder of your hand and body is 15 pounds per square inch and this forces your palm into the bottle.

15—Similar to 1.

16—The atmosphere pressing downward through the upper hole forces the contents of the egg out through the lower hole into the low pressure space in the bottle.

17—The light egg shell is balanced by the heavy shot inside.

18—When the atmospheric pressure increases, it presses down the rubber and compresses the air in the bottle. The downward movement of the center of the rubber then raises the outer end of the pointer.

When the atmospheric pressure decreases, the air in the bottle expands and raises the rubber. The upward motion of the center of the rubber then lowers the outer end of the pointer.

19—The pressure per square inch on the outer surfaces of the sink stoppers is 15 pounds. If the stoppers are 6 inches in

diameter or 3 inch radius, the area of each is $\pi r^2 = \frac{22}{7} \times 3 \times 3$ $= 28+$ square inches and the force on each side is over 28×15 $= 420$ pounds. If there is no air between the stoppers there is no force tending to separate them; and you must exert a force of over 420 pounds on each side to separate them.

20—Similar to 19.

21—Similar to 19.

22—Before you drive air out of the force cup, the pressure of the air in the cup is equal to that of the atmosphere, 15 pounds per square inch. If you drive out half the air, the pressure of the remaining air is 7½ pounds per square inch. If you drive out ⅔ the air, the pressure of the remaining air is ⅓ that of the atmosphere or 5 pounds per square inch.

If the bottom of the force cup is 6 inches in diameter, the area of the bottom is 28+ square inches (See 19). The downward force of the atmosphere on the cup is 420 pounds and the upward force of the atmosphere on 28 square inches of the under side of the stool seat is 420 pounds. If ⅔ of the air is forced out of the cup the pressure of the remaining air inside is 5 pounds per square inch or a total force of 28×5 $= 140$ pounds upward on the under side of the cup and downward on top of the seat inside the cup. The force on each side holding the cup and stool together is $420 - 140$ or 280 pounds.

23—Similar to 22.

24—Similar to 22.

25—*a. c.* The force of the atmosphere on the water surface in the pail holds the water in the can.

b. d. The downward force of the air let into the can opposes the force of the atmosphere, and becomes equal to it when the water levels are the same inside and outside.

26—The force of the atmosphere on the thin film of water between the can cover and the rim of the bottle or tumbler holds the water in the bottle or tumbler.

27—Similar to 25.

28—Similar to 26.

29—*a.* Similar to 25.

b. The water in a siphon always flows from the higher water level to the lower.

FLYING

30—The whirling motion of the propeller drives the air downward with a certain force and the reaction of the air lifts the propeller upward with an equal and opposite force.

31—The dart sails a long distance because its horizontal wings come continually to undisturbed air. They push this air downward and the upward reaction of the air supports the dart.

As the speed of the dart is decreased by air resistance, its wings meet less and less undisturbed air and push it downward with less and less force.

Hence the dart is supported by less and less force and falls to the ground.

32—The folded end of the paper acts as ballast to keep this end of the autogyro down.

The wings by their spinning motion come in contact with more still air than they would if they were not spinning and thereby decrease the falling speed.

Upward currents of air lift the spinning autogyro.

33—You give the cardboard energy of rotation in a horizontal plane and it continues to rotate in that plane until its energy is used up.

34—Any body set spinning in a given plane has energy of rotation in that plane and it will continue to spin *in that plane* until this energy is used up. This is the reason the autogyro does not turn over.

It spins upward at a certain angle because you start it at that angle. It spins downward at a steeper angle because the earth pulls it down.

35—Similar to 34.

36—The paper would fall evenly if the center of the upward air force were always opposite the center of the weight of the paper.

But when the paper glides, the center of the upward air force moves forward and tilts up the front part, mainly because the air stream moving over the front part produces there an area of low pressure. See Experiences, 43-47, with air streams.

Folding the front edge of the paper moves the center of its weight forward and more nearly over the center of the upward

air force, therefore the paper glides without turning over, and the upward reaction of the air supports it until it reaches the ground.

37—The contraction of the balloon rubber drives air out of the balloon in one direction with considerable force and drives the balloon in the opposite direction with equal force.

38—Any falling body must drive the air out of its way and the reaction of the air slows its fall. The cloth of the parachute, having a large area, moves a large amount of air as it falls, and the reaction of the air decreases its downward speed.

39—Similar to 30.

40—Similar to 31.

41—Similar to 31.

42—Similar to 38.

AIR STREAMS

When you produce a rapid stream of air by blowing or otherwise you produce also a low pressure area on all sides of the air stream. This is called Bernoulli's principle.

43—The rapid air stream passing between the card and the table produces a low pressure area between the card and the table and the atmosphere above the card forces it down toward the table.

44—The rapid air stream between the card and the top of the spool produces low pressure in this space and the atmosphere above the card forces it against the top of the spool.

The harder you blow, the more rapid the stream, the less the pressure between the card and spool and the tighter the atmosphere holds the card against the spool.

45—The air stream you blow against the card is directed sidewise, upward and downward by the card and produces low pressure all around the edge of the card. The atmosphere behind the flame forces it toward this low pressure space, and blows the flame *toward* you.

46—The air stream produces a low pressure space above the paper and the atmosphere below the paper lifts it into this low pressure space.

47—The air stream divides and produces low pressure between each half stream and the bottle. Each half stream is held

against the bottle by the atmosphere. They pass around the bottle and unite on the far side to blow out the flame.

48—The air stream enters the bottle curves above the water and shoots out again. If the cork is in the air stream it is lifted out by the outgoing stream.

If the cork is not in the stream at the beginning, it is forced into the low pressure area around the stream by the atmosphere behind it and is lifted out by the outgoing stream.

COMPRESSED AIR AND EXPANDED AIR

Pressure exerted on a confined gas is transmitted equally and undiminished in all directions by the gas. This is Pascal's law for gases.

49—If you blow air into the bag with a pressure of 1 pound per square inch, for example, the outward pressure on each square inch of the inside of the bag is 1 pound. If the area of one side of the bag is say 70 square inches the total lift is 70 pounds.

50—When you blow down hard between the egg and the inside of the egg cup you increase the pressure of the air under the egg and this increased air pressure lifts the egg over into the other cup.

51—When you blow hard at the edge of the half dollar you tip the half dollar and dime and increase the air pressure under the dime. It is this increased air pressure that lifts the dime.

52—The air in the balloon expands and stretches the balloon down into the near vacuum left when the steam condenses to water. The atmosphere pressing on the outside of the balloon tends to force it into the bottle.

53—The air in the balloon expands and stretches the balloon into the near vacuum left when the steam condenses to water.

54—Similar to 52.

55—Similar to 52.

COMPRESSED GAS

56—The baking soda and vinegar combine and produce a large volume of carbon dioxide gas. This gas is confined in a small volume and hence exerts great force. It is this force which drives out the cork.

The liquid which gushes out is white in color because it is filled with gas bubbles.

The chemical equation for the action is:

Baking soda + vinegar = sodium acetate + carbon dioxide + water

$$NaHCO_3 + CH_3COOH = CH_3COONa + CO_2 + H_2O$$

57—*a*. *b*. Similar to 56.

c. The materials in the baking powder combine in the hot water and produce a large volume of carbon dioxide gas. Since this is confined in a small volume it has great force, and this force drives out the cork.

58—Similar to 56, 57.

59—The water in the straw and bottle starts flowing downward, due to its weight and its momentum, or energy of motion, keeps it flowing until the air pressure in the bottle is slightly less than that outside.

The outside air pressure then stops the flow of water downward and forces bubbles of air upward into the bottle. The momentum of the air keeps it flowing upward until the air pressure in the bottle is slightly greater than that outside.

The water starts flowing downward again, and the whole operation is repeated time after time until the bottle is empty.

You use hot water because it is much more fluid than cold water and moves through the straw more readily than cold water.

60—It is difficult to force the balloon into the bottle because the more you force it in the more you compress the air in the bottle and the more you increase the air pressure against the balloon.

Water Wheels and Turbines

61—The force of the running water turns the wheel.

62—Similar to 61.

63—Similar to 61.

64—The water jets shoot from the holes in one direction with a certain force and drive the can in the opposite direction with an equal and opposite force.

Similarly, when you dive in one direction from the end of a boat you spring in one direction with a certain force and drive the boat in the opposite direction with an equal and opposite force.

BUOYANCY OF LIQUIDS

65—Any body placed in a liquid is buoyed up by a force equal to the weight of liquid it displaces. This is the law of Archimedes.

a. The egg sinks to the bottom because the weight of fresh water it displaces is less than its own weight.

c. The egg floats at such depth that it displaces a weight of salt water equal to its own weight.

e. The egg sinks until it displaces a weight of salt and fresh water equal to its own weight.

66—The candle wax is heavier than kerosene but lighter than water, volume for volume.

67—The downward force is equal to the weight of the can plus the weight of the water in it. The buoyant force on the can in water is equal to the weight of the water displaced by the can.

68—The buoyant force on the balloon in water is equal to the weight of the water displaced by the balloon.

69—Similar to 68.

70—When the can is empty the buoyant force on the cardboard is equal to the weight of water that will fill the can to the water level outside the can.

71—The buoyant force on the bottle is equal to the weight of the water displaced by the bottle.

72—The buoyant force on each air bubble is equal to the weight of the water displaced by the bubble.

WATER PRESSURE AND AIR PRESSURE

73—The downward force of the air in the tumbler opposes the upward force of the water and lets the water enter only about ⅛ inch.

74—*b*. The upward force of the water drives air out of the can.
c. The force of the atmosphere on the water surface in the pail supports the water in the can.
The air let into the can exerts a force in opposition to that of the atmosphere outside and its force is equal to that of the atmosphere when the water levels are the same.

75—Similar to 74.

76—*b*. When you suck air out of the can, you decrease the force of the air remaining, and the atmosphere outside drives the balloon into the can.

c. When you blow air into the can you increase the air pressure in the can and this drives the balloon out against the force of the atmosphere outside.

77—*a*. The downward force of the water in the can produces the jet.

c. When you move the sink stopper downward you compress the air above the water. You thereby increase its force on the water and this increases the length of the jet.

78—*c*. Your finger stops the inflow of air and cuts off the force of the atmosphere above the water. The upward force of the atmosphere at the hole in the cover then stops the flow of water.

79—Similar to 78.

80—When you blow in air, you increase the air force above the water and this increases the length of the jet. When you suck air out, you decrease the air force above the water, then the inward force of the atmosphere at the lower hole stops the flow and forces air into the can.

81—The pressure of water at any point is proportional to the depth of that point below the water surface.

82—The pressure of water is equal in all directions at a given depth.

83—*b*. When you suck out air, you decrease the pressure of the air remaining in the can and the atmosphere forces the rubber into the can.

When you let air into the can you increase the air pressure in the can and the elasticity of the rubber moves the rubber out.

c. Similar to b.

84—When you shove the rubber in you exert force on the water and produce the fountain.

85—*c*. The jets are of equal height because pressure exerted on water is transmitted equally and undiminished in all directions. This is Pascal's law.

d. The jets are unequal because the holes are at unequal depths.

86—The contraction of the balloon rubber drives out the water.

87—The contraction of the balloon rubber exerts pressure on the water and this pressure is transmitted equally and undiminished in all directions by the water. Pascal's law.

88—Pressure exerted on water is transmitted equally and undiminished in all directions at a given level. Pascal's law.

LIQUID SURFACES

Surface tension. The surface of any liquid acts as though it were a strong film or sheet which tends to contract to the smallest possible area. This contracting force is called the surface tension or pull of the liquid.

89—The strong surface film of water in each nail hole keeps the water out or in.

90—The strong surface film of water is bent downward by the steel razor blade but it is strong enough to support the blade.

91—Similar to 90.

92—Similar to 90.

93—Similar to 90.

94—Similar to 90.

95—The strong surface film of the water holds the heaped up water in the tumbler.

96—*d.* Since the 4″×2″ part is wet, it has a surface film of water on both sides.

e. The surface film of the water in the pail unites instantly with that on the 4″×2″ part. They contract to the smallest possible area and in doing so *jerk* the 4″×2″ part down.

f. The surface films, on the water in the pail and on the 4″×2″ part, resist being stretched and in doing so stretch the zigzag part.

97—Similar to 96.

98—*d.* The strips are separate because there is no surface film under water to hold them together.

e. The strong surface film of water holds the strips together.

99—*d.* The water enters the cells of the cellulose in the paper and *swells* them.

e. This swelling of the cells at the crease separates the jaws *against* the pull of the surface film of water which is trying to hold them shut.

100—*b*. The strong surface film of the water holds the jets together.

101—The strong surface film of the water holds the water in contact with the pencil or string.

102—The strong surface film of the water holds the water and matches together.

103—A strong surface film of water forms in each open mesh of the cloth and all these separate films acting together hold the water in the tumbler. They are aided by the upward force of the atmosphere.

104—Similar to 103.

105—Similar to 103.

106—Soap added to water decreases the surface tension or pull of the water to less than ½ its usual strength. The pure water surface, not touched by the soap, is over two times as strong as the soapy water surface; it contracts to the smallest possible area, and in doing so, pulls the talcum powder with it and stretches the soapy water surface.

107—The surface tension or pull of gasoline is only about one third that of water. The pure water surface, being three times as strong as the gasoline surface, contracts to its smallest possible area and pulls the talcum powder with it to the side of the plate against the pull of the gasoline surface.

As the gasoline evaporates it leaves the water and the water surface formerly covered by the gasoline comes into play. It contracts and pulls the talcum powder away from the side of the plate.

108—The strong pure water surface outside the loop pulls the loop out in all directions and stretches the weaker soapy water surface inside the loop.

The fact that the loop becomes a perfect circle proves that the pull of the pure water surface outside the loop is equal in all directions, also that the pull of the weaker soapy water surface inside the loop is equal in all directions.

109—The first drop of kerosene weakens the water surface and this permits the surface tension of the kerosene to draw the later drops of kerosene into a large round disk-like drop in the water at the center of the plate.

Soap touched to the surface above the kerosene weakens the surface at this point still further and permits the now

stronger water surface around it to pull the kerosene and talcum powder to the edge of the plate instantly.

The whole water surface is now soapy and weak, and the surface tension of the kerosene being stronger pulls the kerosene into spherical drops.

Remember that any liquid surface contracts to the smallest possible area, and the sphere is the shape which has the smallest possible area for a given volume.

Hence the kerosene is drawn into spheres by its surface tension.

Similarly rain drops are spheres because the surface tension of water draws the falling water into this shape.

110—*a*. Camphor dissolves in water irregularly and where it dissolves most, it weakens the surface most. The stronger water surface on the opposite side then draws the camphor to that side.

Next instant the camphor is dissolving more rapidly at another point and the camphor is pulled in the direction opposite this point.

Hence each camphor particle moves about in a very irregular manner.

b. The soap weakens the water surface much more than does the camphor and the stronger water surface around the edge pulls the camphor particles to the edge of the plate.

The camphor particles stop moving because the whole surface is now soapy and so weak that the camphor particles have no further weakening effect.

111—The camphor at the stern weakens the water surface at the stern and the stronger water surface at the bow pulls the boat forward.

112—The soap speck dissolves irregularly in water and the results are similar to 110a. The soap weakens the water surface so much more rapidly than the camphor, that its irregular motions stop sooner than those of camphor.

113—The soap or camphor weakens the surface tension in the spiral and at its outlet. The stronger water surface on the far side of the spiral opposite the outlet pulls the spiral around.

114—*b*. The thick coating of soot on the paper prevents the water from touching the paper, hence the surface tension of the water can draw it into drops.

The attraction between water and paper is stronger than the attraction between water and water. Hence water which touches the paper is drawn down into the paper and the drop is destroyed.

115—*b.* Similar to 114 b.

116—*a.* A cushion of steam is formed under the water the instant the water strikes the red hot tin. This cushion keeps the water above the metal and the surface tension of the water draws it into spheres.

The water changes into steam continuously and in time disappears.

b. The surface tension draws the water into spherical drops.

117—This shows that a liquid surface contracts to the smallest possible area.

118—This shows that a very small surface may be stretched into a very large surface.

119—If the soda straw is wet, it passes through the bubble without breaking it.

120—This shows that a liquid surface contracts to the smallest possible area.

121—This shows that the tension or pull of the soap film is equal in all directions.

OTHER PROPERTIES OF WATER

122—Water passes through the skin of the peas or beans and swells them with such great force that it bursts the bottle. This force is called Osmotic Pressure.

Water swells seeds planted in moist ground with this same great force.

123—Similar to 122.

124—In osmosis the liquid always moves toward the stronger solution. In this case the water moves from the tumbler through the membrane of the egg into the stronger solution in the egg. It moves with sufficient osmotic pressure to drive the contents of the egg up through the straw.

125—The skin of fruits, seeds and vegetables is a membrane permeable to water but not to the substances in solution in the juices of the fruits, seeds and vegetables.

Water moves through the skin by osmosis and swells the fruits, seeds and vegetables by osmotic pressure.

126—A *molecule* of any substance is the smallest particle of that substance which can exist and still retain the properties of the substance.

A molecule of water, for example, is the smallest particle of water that can exist and still be water.

The molecules of any substance are in constant and rapid motion, if it is warm, and the warmer the substance the more rapid is the motion of its molecules.

Water evaporates, that is, water molecules, due to their motion, escape into the air above the water and the larger the surface the more rapid the evaporation.

127—If you wish to boil water on the stove you must supply heat to warm the water and to turn the water into steam.

When you blow on your hand you change perspiration (water) into water vapor (steam). The heat to do this comes from your hand and your hand feels cool.

128—The ice cools the warm moist air and the water molecules come together as small water drops. Millions of small water drops make a fog or cloud.

When these small drops come together as larger drops they become rain.

129—Similar to 128.

130—The ice and salt produce a temperature below freezing, that is, below 32° F.

They cool the air which comes into contact with the can and cause the water molecules from the air to collect on the can as *dew* drops, then they freeze these drops to ice and produce *frost*.

They freeze the water beneath the can to ice which cements the paper to the can.

131—Water in nature has air dissolved in it and fish in water live by absorbing this air through their gills.

Water delivered to you through pipes has been in contact with air under high pressure and it has dissolved more air than water in brooks.

It is this excess air which appears at the top of the bottles.

132—One substance dissolved in water is driven out by another substance which dissolves more readily in water.

Air is driven out of water by salt which dissolves in water more readily than does air.

133—Carbon dioxide gas is driven out of water by sugar, which dissolves in water more readily than does the gas.

134—The molecules of sugar dissolved in water are in constant and rapid motion just as the molecules of water are.

The molecules of sugar gradually move upward against the force of gravity and in time distribute themselves uniformly through the water. This process is called diffusion. It occurs in every solution in nature. The soap acts in a similar manner.

135—When alum separates as a solid from a concentrated solution it forms in regular geometrical forms called *crystals.*

Many substances do this, for example, salt, sugar, and ice.

136—Tiny crystals form where the pen has left a trace. They scrape more lead from the pencil than does the surrounding paper and thereby make the writing visible.

137—When water turns to a solid it produces at first long thin crystals of ice. You may have seen these on the edge of a brook or pond or as shell ice on water puddles.

A pound of ice occupies more space than a pound of water because there are open spaces between the crystals.

Similarly a pound of iron nails occupies more space than a pound of iron because no matter how closely you pack the nails there are open spaces between them.

All ice crystals tend to form as pure water solidified and to exclude all substances dissolved in the water. Hence the first ice crystals formed exclude the air dissolved in the water. The later ice crystals have air mixed with them not as invisible dissolved air but as excluded visible air bubbles.

138—Water in forming ice crystals expands with enormous force and bursts the bottle.

Similarly ice forming in iron water pipes may burst the pipes.

139—Ice at the freezing temperature of water, 32° F., evaporates almost as readily as water at the same temperature. The ice turns to water vapor without going through the liquid stage. Hence the towel dries although the water on it is in the form of ice.

BALANCE

140—Any body is balanced when the imaginary straight line from its center of gravity to the center of the earth passes inside its base.

The center of gravity of any body is the center of its weight.

When you bend over to pick up the handkerchief you begin to fall, because the vertical line from your center of gravity passes outside your base, your feet.

141—Your base at first is the space covered by your feet and the space between two lines running from the outside of your feet to some point beyond the wall.

The instant you remove your head from the wall, however, your base is only the space covered by your feet.

The vertical line from the center of the combined weight of your body and the chair passes very far outside this base and you are too much out of balance to straighten up.

142—You tip over unless you keep your center of gravity over your base—the space between the lower legs of the chair.

143—It is balanced when the vertical line through the center of gravity of the whole device passes through the point of support—the base.

144—Similar to 143.

145—Similar to 143.

146—Similar to 143.

147—Similar to 143.

148—Similar to 143.

149—A floating body is in stable balance when its center of gravity is as low as possible. For this reason, a single long cylindrical cork is in stable balance only when it is floating on its side.

This is true also of two corks.

Three corks held together by the water between them may float upright.

Four or more corks held together by the water between them will float upright.

150—The pennies inserted near the tips of the wings move the center of the weight of the butterfly and pennies toward the

head of the butterfly. They also bend the wings down slightly and bring the center of weight slightly below the head. The butterfly will balance if the pencil head is in the vertical line through the center of weight.

EXPERIENCES WITH YOUR BODY

151—Your friend's outstretched arms make a long lever which you can turn up or down by exerting a small force at the end of the lever and at right angles to it.

152—Similar to 151.

153—Your hand trembles slightly no matter how steady you try to hold it and these small movements move the hair pin.

154—*a*. Your pulse tips the thumb tack and the thumb tack moves the match.

b. Your pulse moves the mirror and the mirror moves the reflected light.

155—This takes a little practice.

INERTIA

Inertia is defined as the tendency of a body at rest to remain at rest and, the tendency of a body in motion to continue in motion in the same straight line.

156—The inertia of the egg keeps it at rest while you jerk the cardboard and match box sidewise. It is then pulled down into the egg cup by gravity, the attraction of the earth.

157—The inertia of the coin keeps it at rest while the card slides out from under it.

The coin then falls into the bottle because it is pulled downward by the attraction of the earth.

158—The inertia of the tumbler and water is overcome when you move the paper slowly but not when you move the paper rapidly.

159—When you pull down slowly, the force on the lower cord is your pull and the force on the upper cord is your pull plus the weight of the rock. The upper cord breaks.

When you pull down quickly, the force on the lower cord is your pull plus the inertia, or resistance to motion, of the rock, the force on the upper cord is only the weight of the rock. The lower cord breaks.

160—When you pull gently the force on the thread is only the friction between the rock and the table.

When you pull quickly the force on the thread is the friction plus the inertia, or resistance to motion, of the rock, and the thread breaks.

161—The inertia of the upper coins is not overcome when the bottom coin shoots out and the pile remains upright but shorter by one coin.

162—A fresh egg at room temperature is fluid inside and when you spin it you spin the shell but not its contents. The inertia of the contents stops the shell quickly.

A hard boiled egg is solid inside and when you spin it you spin the shell and its contents and the inertia of motion of the contents keeps the egg spinning.

163—The inertia of the part of the pencil under the paper prevents it from moving when the outer half of the pencil is moved by the ruler and the pencil breaks.

164—The inertia of motion of the potato keeps it moving after you have stopped pulling on the cord and it winds up the cord in the reverse direction.

165—The weight keeps the center of the bands from turning and the inertia of motion of the can twists up the bands on both sides of the weight. The resistance to twisting in time stops the motion of the can, and the energy of twisting stored up in the bands rolls the can back.

166—The inertia of motion of each particle of water tends to make it move at each instant along the straight line in which it is then moving—a tangent to the circle. This tendency keeps the water in the pail. It is overcome by the pull of your arm toward the center of the circle.

167—The inertia of motion of each particle of moving water tends to make it move away from the center of the pail. It makes the water creep up the inside of the pail and over the edge.

MARBLES

168—The energy of motion of the rolling marble is transmitted from one marble to the next, by the compression and expansion of each marble in turn, and given to the end marble.

169—The inertia of motion of the marble keeps it moving and also pressing outward on the inside of the can. As a result the marble loops the loop inside the can a number of times.

170—Rolling friction is always less than sliding friction.

SCIENCE TOYS

171—The inertia of motion of the wheel tends to keep it spinning *in the same plane* for the reason given.

172—The inertia of motion of the spinning top tends to keep it spinning *in the same plane* for the reason given in 171. Hence the top does not fall over until its energy of motion is overcome by the friction of the air around it and by the friction between its point and the floor.

173—The inertia of motion of the Yo-Yo tends to keep it moving and winds it up hill on the cord.

174—The inertia of motion of the spinning disk twists the cords together.

175—The end of the stick is given a jolt each time the pencil drops into a notch and the pressure of the thumb on the side of the stick makes these jolts follow one another in a circular path in one direction. This motion of the end of the stick sets the propeller revolving in the same direction.

The pressure of the finger on the top side of the stick makes the jolts follow one another in a circular path in the opposite direction and this motion of the end of the stick sets the propeller revolving in the opposite direction.

176—An elastic body is one that regains its first shape completely after it has been stretched, compressed or twisted and then released. Rubber is very elastic.

177—The expanding steam issues from two pipes at the stern. It drives the water backward and the boat forward with equal and opposite forces.

178—The air you compress behind the pea drives it forward.

179—Similar to 178.

180—Similar to 178.

181—When you pull the trigger you pull back the barrel against a spring and force air out of the barrel. When you release the trigger with the barrel under water the spring forces the barrel outward and atmospheric pressure on the water

surface forces water into the barrel. When you pull the trigger again you pull back the barrel and force the water out of the barrel.

182—The air streams on all sides of the ball produce an area of low pressure between the ball and the streams. If then the ball starts to fall out of the stream the greater atmospheric pressure on the side away from the stream forces the ball back into the air streams.

183—A strip spring along one side of the tube keeps the tube curled up. When you blow air into the tube with a given pressure, the air transmits this pressure equally and undiminished to every part of the inside of the tube and the total force outward is great. This force straightens the tube.

HEAT

Manufactured gas is made by the destructive distillation of organic matter, for example, hay, straw, wood, coal and oil.

Destructive distillation is the breaking up of organic matter by means of heat.

184—Paper is made from wood, and the heat breaks it up into water vapor, gas, creosote, and charcoal.

185—Similar to 184.

186—The heat of the burner breaks up the coal into coal gas, coal tar and coke.

187—The heat breaks up the cloth into water vapor, gas and charcoal.

188—A spark lights the tinder but you must blow to supply oxygen and produce a flame.

189—The boiling temperature of water is 212° F. and the temperature at which paper takes fire is much above 212° F. The paper conducts heat so rapidly from the flame to the water that its temperature does not rise much above 212° F. and since this temperature is below its kindling temperature it does not take fire.

190—The cold water is heavier than hot water volume for volume. Cold water from the pail enters the bottle, sinks to the bottom of the bottle and forces the hot colored water upward.

191—Similar to 190.

192—The steam forming in the funnel can force its way out either through the stem of the funnel or down under the inverted top of the funnel. It forces its way out of the stem and carries water with it in "perks" because the mixture of water and steam in the funnel and funnel stem is lighter volume for volume than the water outside the funnel. A coffee percolator "perks" for the same reason.

193—Cold air is heavier volume for volume than hot air. The cold air around the source of heat sinks down and lifts the hot air above the source of heat and thereby produces an upward current of hot air which turns the hot-air wheel.

194—Similar to 193.

195—The cold air around the cooling unit is heavier volume for volume than the warmer air elsewhere in the refrigerator. It sinks down and turns the air wheel.

196—Cold air is above, below and on all sides of the hot air in the bag. It is heavier volume for volume than the hot air and it lifts the hot air up just as water lifts up a piece of wood shoved down into it.

197—*a*. The hot candle wax turns to oil, the oil turns to gas and it is the gas which burns. The smoke is mostly gas and it lights readily.

b. The oil on the wick turns to gas and it is the gas which burns. The smoke is mostly gas and it lights readily.

198—The candle, oil and gas in burning produce chiefly carbon dioxide gas and water vapor. You detect the water vapor.

199—Cold air moves down one side of the partition and supplies oxygen to the flame. The hot burned gases escape at the other side of the partition.

200—The top of the candle floats about ⅛ to ¼ inch above the water surface.

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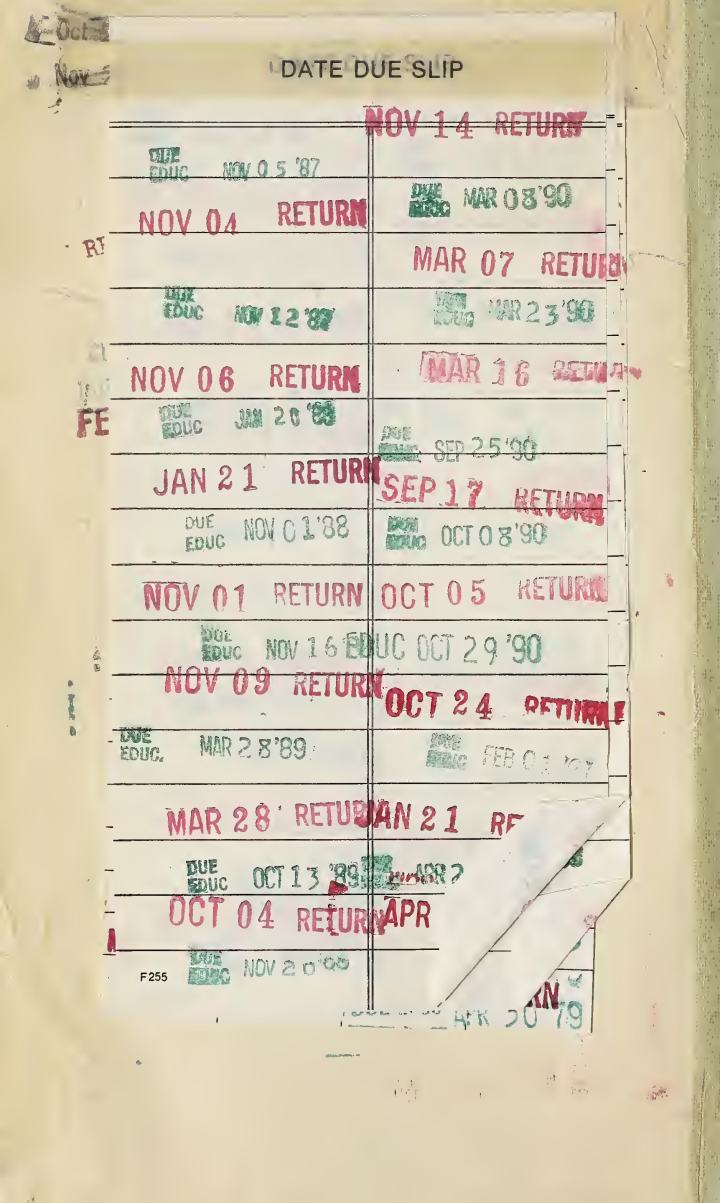
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